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Waste Minimization Opportunity Assessment, Fort Riley, Kansas

Versar, Inc., Springfield, VA

Prepared for:

Environmental Protection Agency, Cincinnati, OH

Jul 90

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July 1990

WASTE MINIMIZATION OPPORTUNITY ASSESSEMENT
FORT RILEY, KANSAS

by
Versar Inc.
Springfield, Virginia 22101

Contract No. 68-C8-0061

James S. Bridges
Waste Minimization Branch
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

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16. ABSTRACT

Under the Waste Reduction Evaluations at Federal Sites (WREAFS) Program, a waste minimization opportunity assessment was conducted at a maintenance operation carried out at one of the U.S. Army Forces Command (FORSCOM) Fort Riley, Kansas facilities. These facilities generate waste battery acid and metals-contaminated alkaline wastewaters. The waste minimization assessment developed two recycling options for these RCRA wastes: 1. Filtration, restrengthening and recycling of waste battery acid as a replacement for virgin battery acid and, 2. purification and reuse of alkaline detergent solution for automotive parts cleaning. The payback periods for these two waste reduction options are very short and create the potential for application of similar waste minimization options in at least ten other U.S. Army FORSCOM installations.

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This material has been funded wholly or in part by the United States Environmental Protection Agency under Contract 68-C8-0061 to the Waste Minimization Branch of the Risk Reduction Engineering Laboratory. It has been subject to the Agency's review and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking waster, wastewater, pesticides, toxic substances, solid and hazardous waste, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The Waste Minimization Branch of the Risk Reduction Engineering Laboratory has instituted the Waste Reduction Evaluations at Federal Sites (WREAFS) Program to identify, evaluate and demonstrate waste minimization opportunities in industrial and military operations. This report is an assessment conducted at the U.S. Army Forces Command (FORSCOM) maintenance facilities at Fort Riley, Kansas.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

The Waste Reduction Evaluations at Federal Sites (WREAFS) Program consists of a series of demonstration and evaluation projects for waste reduction conducted cooperatively by EPA and various parts of the Department of Defense (DOD), Department of Energy (DOE), and other Federal agencies. The WREAFS program focuses on waste minimization research opportunities and technical assessments at Federal sites. The objectives of the WREAFS Program include: (1) Conducting waste minimization workshops; (2) performing waste minimization opportunity assessments; (3) demonstrating waste minimization techniques or technologies at Federal facilities; and (4) enhancing waste minimization benefits within the Federal community.

One of the WREAF sites chosen for performance of a waste reduction assessment is Fort Riley, Kansas. Maintenance operations carried out at one of the U.S. Army Forces Command (FORSCOM) Fort Riley, Kansas facilities, generates waste battery acid and metals-contaminated alkaline wastewaters. Battery acid from car and truck batteries requiring maintenance or disposal, currently is collected in drums and shipped to the Defense Reutilization and Marketing Office (DRMO) at the installation for disposal as hazardous waste (D002, D006, D008). Automative parts currently are cleaned with hot aqueous alkaline detergent in a batch washer, and a metal-contaminated waste detergent solution is drained to an on-site nonhazardous waste evaporation pond. This waste is currently being reclassified as RCRA, D007 and D008.

A waste minimization assessment at Ft. Riley has developed the following recycling options for these RCRA wastes:

1. Filtration, restrengthening and recycle of waste battery acid as a replacement for virgin battery acid.

2. Purification and reuse of alkaline detergent solution for automative parts cleaning.

This report was submitted in fulfillment of Contract 68-C6-0061 by Versar Inc. under the sponsorship of the U.S. Environmental Protection Agency's Risk Reduction Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the waste reduction assessment.

TABLE OF CONTENTS

Page

DISCLAIMER ii

FOREWORD iii

ABSTRACT iv

LIST OF TABLES vi

LIST OF FIGURES vii

SECTION 1 PROJECT OVERVIEW 1

- PURPOSE 1
- PROCEDURES 1
- ORGANIZATION OF REPORT 6

SECTION 2 SITE DESCRIPTION 7

- GENERAL DESCRIPTION OF FORT RILEY, KANSAS 7
- WASTE MANAGEMENT AT FORT RILEY 9
  - Chain of Responsibility 9
  - Sources of Hazardous Waste at Fort Riley 9
  - Hazardous Waste Handling Procedure 11
  - Packaging and Movement of Hazardous Wastes at Fort Riley 11
- DESCRIPTION OF OPERATIONS SELECTED FOR THE WASTE MINIMIZATION ASSESSMENT 13
  - Building 8100, Area 5, Battery Repair Shop 13
  - Building 8100, Area 1, Automotive Subassembly Rebuild (Automotive Parts Washing) 16

SECTION 3 ASSESSMENT PHASE RESULTS 19

- SUMMARY OF ASSESSMENT PHASE 19
- DESCRIPTION OF WASTE MINIMIZATION OPTION FOR WASTE BATTERY ACID 19
  - Recycle of Waste Battery Acid 21

TABLE OF CONTENTS
(Continued)

Page

SECTION 3 (Continued)

DESCRIPTION OF WASTE MINIMIZATION OPTION FOR THE AUTOMOTIVE PARTS WASHER WASTEWATER. 21

Recirculation of Tornado Washer Wastewater Following Cleanup 23

SECTION 4 FEASIBILITY ANALYSIS RESULTS 25

SUMMARY OF FEASIBILITY ANALYSIS PHASE 25
RECOMMENDATIONS 25

APPENDICES

A. WASTE MINIMIZATION ASSESSMENT WORKSHEETS-BUILDING 8100 BATTERY REPAIR SHOP 29

B. WASTE MINIMIZATION ASSESSMENT WORKSHEETS-BUILDING 8100 AUTOMOTIVE PARTS WASHER WASTEWATER. 62

C. MATERIALS SAFETY DATA SHEETS AND OTHER PERTINENT RAW MATERIALS DATA. 95

LIST OF TABLES

Number Page

1 List of Waste Minimization Assessment Worksheets. 4

2 Hazardous Waste Generation at Fort Riley in 1988. 10

3 Pertinent Operational Data Obtained at the Fort Riley Battery Repair Shop (Building 8100, Area 5) 18

4 Summary of Waste Minimization Assessment Phase. 20

5 Summary of Factors Determining Technical Feasibility of Two WM Options Studied. 26

6 Summary of Waste Minimization Options Cost Analysis Data. . 27

LIST OF FIGURES

Number Page

1 The Waste Minimization Assessment Procedure 2

2 Fort Riley Location Map Showing Open Burning/Open Detonation Area and Hazardous Waste Storage Facility. . . . 8

3 Example of the Turn-In Document for Generators of Hazardous Materials and Hazardous Waste 12

4 Simplified Schematic of Building 8100 14

5 Block Flow Diagram, Battery Shop Operation Building 8100. . 15

6 Simplified Schematic, Automotive Parts Cleaning in Building 8100 17

7 Proposed Equipment for Waste Battery Acid Options 22

8 Proposed Equipment for Tornado Parts Washer Wastewater Option 24

SECTION 1

PROJECT OVERVIEW

PURPOSE

The purpose of this project was to develop waste minimization (WM) options for the principal hazardous waste generating areas at the Fort Riley, Kansas, Army Forces Command (FORSCOM) installation. The procedures described in the Environmental Protection Agency's (EPA) Waste Minimization Opportunity Assessment Manual were to be used in this effort. This manual provides a systematic methodology for identifying ways to reduce or eliminate waste. The development of this procedure was supported by the Risk Reduction Engineering Laboratory (RREL), U.S. Environmental Protection Agency, Cincinnati, Ohio.

The current project was conducted in cooperation with the Environmental Office of the Directorate of Engineering and Housing (DEH) at Fort Riley. This department has an on-going program for waste minimization. With DEH guidance, two hazardous waste-generating operations were selected for application of the EPA waste minimization procedures. DEH plans to utilize the results of this project as guidance in implementing projects for reduction and/or elimination of some of the major hazardous wastes generated at Fort Riley.

PROCEDURES

The project was initiated when the EPA contractor segment of the assessment team received data from the Fort Riley Environmental Office on the amounts of hazardous waste streams generated at various onsite facilities during 1988.[a] These data were reviewed by the contractor, and preliminary decisions were made to perform studies of several of these waste streams during the detailed site inspection planned for Fort Riley as part of the overall assessment. Prior to performing the detailed site inspection, the assessment team met with the Fort Riley segment of the assessment teams at the Fort Riley Environmental Office to consolidate the items on the team's data needs list. This list was initially based on review of the available hazardous waste generation data received from Fort Riley. At this meeting the assessment team obtained concurrence from DEH Environmental Office management personnel on the choices of waste streams for detailed evaluation. The assessment team then proceeded to complete the following steps (following the procedure illustrated in Figure 1):

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[a] In the Ist Infantry Division (M) and Fort Riley Hazardous Waste Minimization Plan as presented in the RCRA Part A and Part B Permit Application for Hazardous Waste Management Facility, O'Brien and Gene Engineers, Inc., St. Louis, Missouri, 1989.

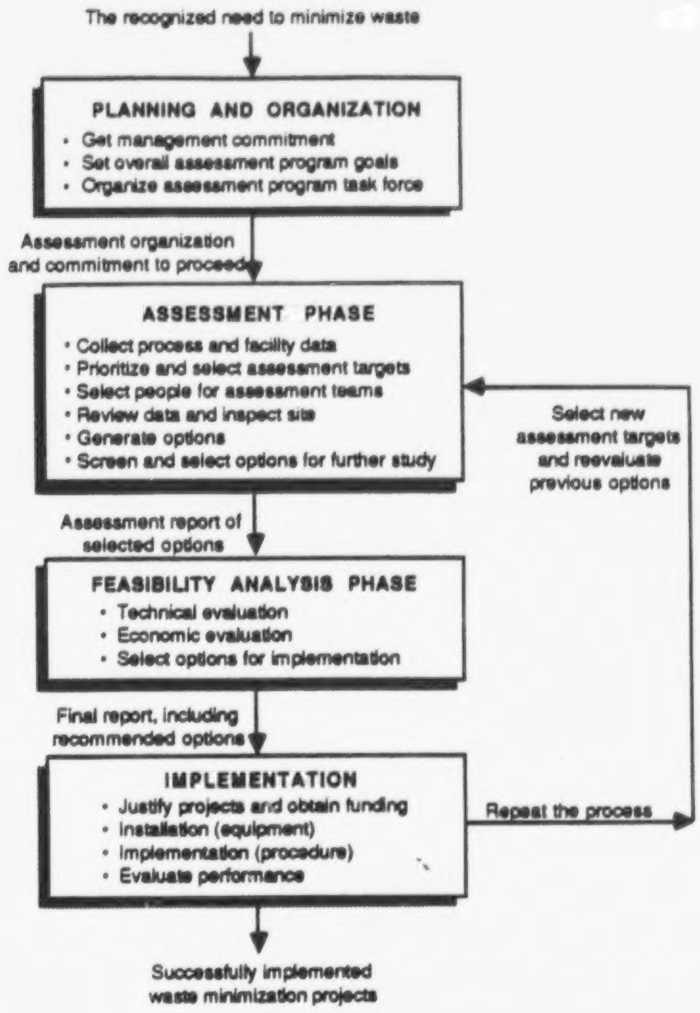
The recognized need to minimize waste
PLANNING AND ORGANIZATION
· Get management commitment
· Set overall assessment program goals
· Organize assessment program task force
Assessment organization and commitment to proceed
ASSESSMENT PHASE
· Collect process and facility data
· Prioritize and select assessment targets
· Select people for assessment teams
· Review data and inspect site
· Generate options
· Screen and select options for further study
Select new assessment targets and reevaluate previous options
Assessment report of selected options
FEASIBILITY ANALYSIS PHASE
· Technical evaluation
· Economic evaluation
· Select options for implementation
Final report, including recommended options
IMPLEMENTATION
· Justify projects and obtain funding
· Installation (equipment)
· Implementation (procedure)
· Evaluate performance
Repeat the process
Successfully implemented waste minimization projects

Figure 1. The Waste Minimization Procedure.

(1) Planning and Organization - Organization and goal setting. This step was carried out prior to and during the detailed site assessment.

(2) Assessment - Careful review of facility operations and waste streams and identification and screening potential options to minimize waste. This step was begun during the detailed site visit and was subsequently completed by assessment team members at their offices.

(3) Feasibility Analysis - Evaluation of the technical and economic feasibilities of the selected waste minimization options and selection of options for implementation. This step was completed by the assessment team and included review of the selected options by the Fort Riley engineering personnel.

(4) Implementation - Procurement, installation, implementation, and evaluation. The assessment team has made recommendations to Fort Riley management personnel for implementation of the selected options.

The EPA Waste Minimization Opportunity Assessment Manual contains a set of 19 worksheets that are designed to facilitate the WM assessment procedure. Table 1 lists the worksheets according to the particular phase of the program in which they are employed and provides a brief description of the purpose of each worksheet. Worksheets 1 through 16 were completed for the assigned areas during this project and are presented in Appendices A, B, C, for the three waste streams studied.

The following two hazardous waste generation areas at Fort Riley were selected for evaluation during this project:

- Building 8100 - battery service and repair shop

- Building 8100 - automotive subassembly rebuild shop (alkaline hot water washing of automotive parts)

The assessment phase of the project was initiated with a 2-day survey conducted by engineers from Versar and supported by the Directorate of Engineering and Housing Environmental Office, with cooperation from the appropriate service departments at Fort Riley. The survey focused on the collection of process and waste data and the identification of procedures for waste management. Before and during the survey, the assessment team completed most sections for Worksheets 2 through 9. the survey was concluded with a briefing of the Director of the Directorate of Engineering and Housing.

After completion of the survey, the Versar team continued to collect data and information from Fort Riley through telephone contacts. This time period was also used to verify data and resolve any informational discrepancies. Versar then completed assessment and feasibility analysis phases of the WM assessment (Worksheets 10 through 13, and 14 through 16) respectively.

TABLE 1. LIST OF WASTE MINIMIZATION WORKSHEETS

Worksheet Number and Title	Purpose/Remarks
1. Assessment Overview	Summarizes the overall assessment procedure.
Planning and Organization (Section 2)	
2. Program Organization	Records key members in the WMA program task force and the WM assessment teams. Also records the relevant organization.
3. Assessment Team Make-up	Lists names of assessment team members as well as duties. Includes a list of potential departments to consider when selecting the teams.
Assessment Phase (Section 3)	
4. Site Description	Lists background information about the facility, including location, products, and operations.
5. Personnel	Records information about the personnel who work in the area to be assessed.
6. Process Information	This is a checklist of useful process information to look for before starting the assessment.
7. Input Materials Summary	Records input material information for a specific production or process area. This includes name, supplier, hazardous component or properties, cost, delivery and shelf-life information, and possible substitutes.
8. Products Summary	Identifies hazardous components, production rate, revenues, and other information about products.
9. Individual Waste Stream Characterization	Records source, hazard, generation rate, disposal cost, and method of treatment or disposal for each waste stream.
10. Waste Stream Summary	Summarizes all of the information collected for each waste stream. This sheet is also used to prioritize waste streams to assess.
11. Option Generation	Records options proposed during brainstorming or nominal group technique sessions. Includes the rationale for proposing each option.
12. Option Description	Describes and summarizes information about a proposed option. Also notes approval of promising options.
13. Options Evaluation by Weighted Sum Method	Used for screening options using the weighted sum method.

(Continued)

TABLE 1. (CONTINUED)

Worksheet Number and Title	Purpose/Remarks
Feasibility Analysis Phase (Section 4)	
14. Technical Feasibility	Detailed checklist for performing a technical evaluation of a WM option. This worksheet is divided into sections for equipment-related options, personnel/procedural-related options, and materials-related options.
15. Cost Information	Detailed list of capital and operating cost information for use in the economic evaluation of an option.
16. Profitability Worksheet #1 Payback Period	Based on the capital and operating cost information developed from Worksheet 15, this worksheet is used to calculate the payback period.
17. Profitability Worksheet #2 Cash Flow for NPV	This work sheet is used to develop cash flows for calculating net present value and IRR (NPV) or internal rate of return (IRR).
Implementation (Section 5)	
18. Project Summary	Summarizes important tasks to be performed during the implementation of an option. This includes deliverable, responsible person, budget, and schedule.
19. Option Performance	Records material balance information for evaluating the performance of an implemented option.

ORGANIZATION OF REPORT

This report contains four sections and four appendices. Section 1 provides an overview of the project. Section 2 describes the Fort Riley facilities, the industrial activities surveyed during this project, and the waste management procedures currently employed at Fort Riley. Section 3 presents the results of the assessment phase, including the selection of waste minimization options. Section 4 contains the results of the feasibility analysis phase, including recommendations. Appendices A and B represent the Waste Minimization Worksheets (2-16) completed for each of the waste generation activities studied. Appendix C contains Materials Safety Data Sheets and other pertinent data on raw materials used in the industrial processes under consideration.

SECTION 2

SITE DESCRIPTION

GENERAL DESCRIPTION OF FORT RILEY, KANSAS[a]

Fort Riley is a permanent U.S. Army Forces Command (FORSCOM) Installation that provides support and training facilities for the Ist Infantry Division (Mechanized), Non-Divisional Units, and tenant activities. It is a U.S. Government owned, U.S. Government operated facility that occupies approximately 121,000 acres in north central Kansas within Geary and Riley Counties. The Main Post, one of five cantonments located on the southern portion of the installation, lies approximately 65 miles west of Topeka and 50 miles east of Salina. Urbanized areas near the main post include Junction City (3 miles), Ogden (3 miles), and Manhattan (12 miles). The other four cantonments located on the southern portion of the installation are Camp Whitside, Camp Forsyth, Camp Funston, and Custer Hill. Fort Riley is bordered on the south by the Kansas and Republican Rivers. Marshall Army Airfield (MAAF) is located on the south side of the Kansas River, directly across from the Main Post. The location and layout of Fort Riley are shown in Figure 2.

Fort Riley provides the Army with the capability to house and train an Army division and associated land combat forces, as well as to service Army functions in an assigned midwest support area. This mission necessitates accomplishment of a multitude of diverse tasks. Broadly grouped into major categories, these tasks are: administration, construction, operation and maintenance, procurement, real estate, and training. Neither industrial production nor research, development, testing, or evaluation tasks are routinely pursued. In general, the great preponderance of Fort Riley's tasks are either training of military units or operation and maintenance of installation property. The future missions of Fort Riley are expected to remain the same.

Routine mechanical maintenance of the Ist Infantry Division's vehicles (trucks, tanks, armored personnel carriers, etc.) is carried out in Division motor pools located at various areas on the post. Major equipment repairing and rebuilding, however, is carried out by a civilian contractor, EC Services, Knoxville, Tennessee, with all of these activities located in Building 8100 on the base.

The hazardous wastes generated at Fort Riley consist of spent automotive cleaning solvents (which are recycled through a Safety-Kleen waste pickup and recycling contract) and various RCRA listed hazardous waste disposed of by the Defense Reutilization and Marketing Office (DRMO), which is a subelement of the Defense Logistics Agency, Department of Defense, co-located at Fort Riley. Most of the disposed hazardous waste (with the exception of waste ordinance)

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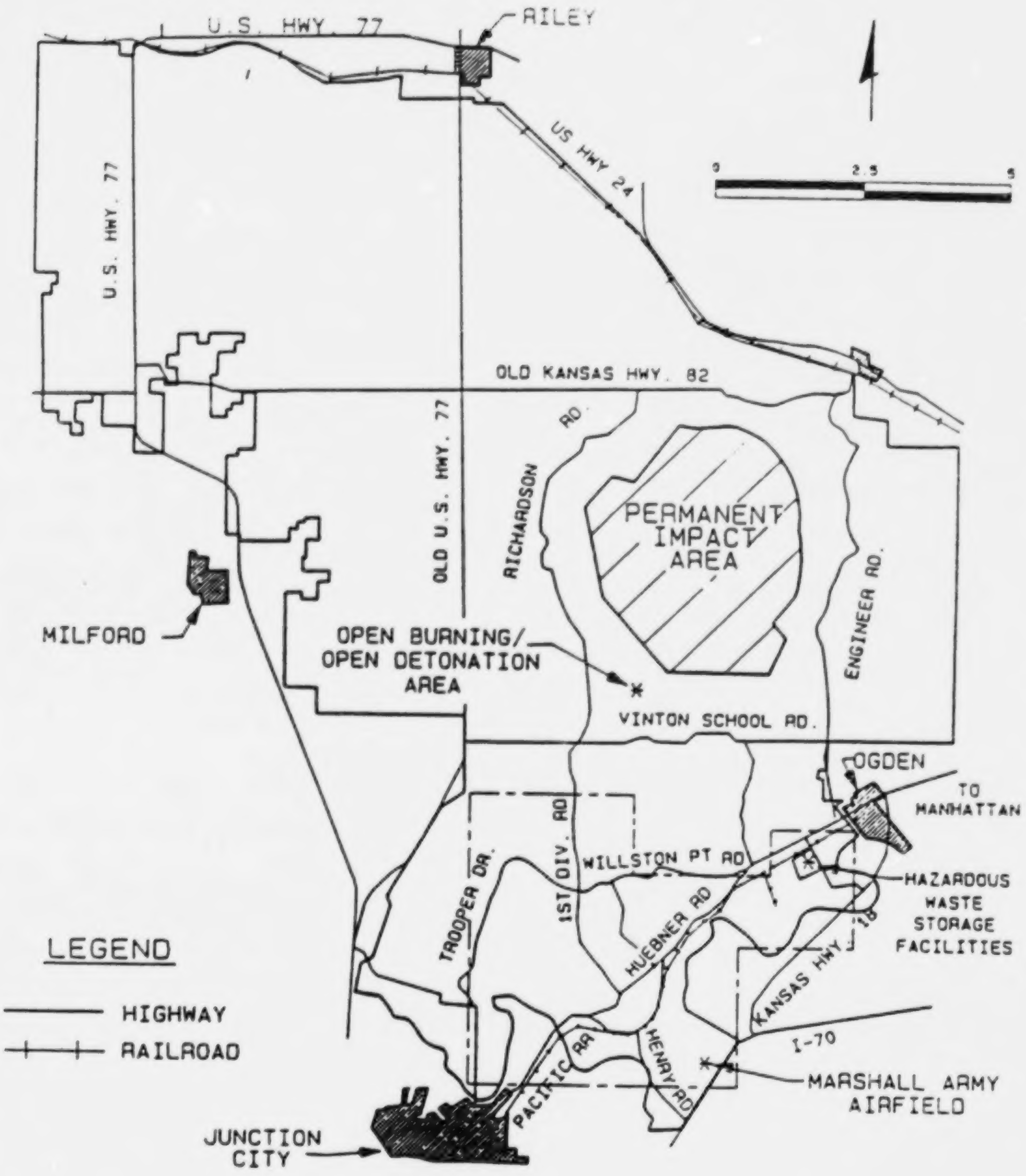
[a] Much of the descriptive material in this section and Section 2.2 is taken from the RCRA Part A and B Permit Application for Hazardous Waste Management Facility prepared by O'Brien and Gere, St. Louis, Missouri, 1989.



U.S. HWY. 77
RILEY
US HWY 24
0
2.5
5
U.S. HWY. 77
OLD KANSAS HWY. 82
OLD U.S. HWY. 77
RICHARDSON RD.
PERMANENT IMPACT AREA
ENGINEER RD.
MILFORD
OPEN BURNING/ OPEN DETONATION AREA
VINTON SCHOOL RD.
OGDEN
TO MANHATTAN
TROOPER DR.
1ST DIV. RD
WILLSTON PT RD
HUEBNER RD
HAZARDOUS WASTE STORAGE FACILITIES
KANSAS HWY. 18
LEGEND
HIGHWAY
RAILROAD
I-70
PACIFIC RR
HENRY RD
MARSHALL ARMY AIRFIELD
JUNCTION CITY

Figure 2. Ft. Riley Location Map Showing Open Burning/Open Detonation Area and Hazardous Waste Storage Facility.

is generated in Building 8100 and includes waste battery acid, waste caustic cleaners, and spent automotive parts wash water. Hazardous wastes generated at Fort Riley are listed in Table 2.

WASTE MANAGEMENT AT FOR RILEY

Chain of Responsibility

The three groups at Fort Riley with principal roles in the management of hazardous wastes are the Directorate of Logistics (DOL), the Directorate of Engineering and Housing (DEH), and DRMO.

The Commanding General at Fort Riley has ultimate responsibility for waste management at the post. This responsibility is delegated to the Garrison Commander who has two groups reporting to him in terms of these activities--the DEH, which has charge of the day-to-day oversight of waste management (including review and sign-off of hazardous waste manifests and responsibility for the waste management program at the base), and the DOL, which has responsibilities for the various shop operations, including Building 8100 where the hazardous wastes of concern in this study, are generated. In Building 8100, the EC Services Contracting Office Representative is responsible for identifying hazardous wastes, spills, and improper storage and for ensuring that the shop is properly disposing of all wastes.

The DRMO office of Fort Riley is responsible for disposal of all hazardous DOD property except for those categories of materials designated for DOD component disposal. Not all property received by the DRMO is or becomes a regulated hazardous waste. Unless otherwise required by regulation, a nonhazardous item is turned over to the DRMO, which then tries to reutilize (R) it within the Defense Department, transfer (T) it to a certified State agency, donate (D) it to a certified nonprofit organization, or sell (S) it to the public. Thus, the property moves through the RTD/S cycle as required by Congress to save the taxpayer's money. If the DRMO receives a hazardous waste that is determined to be unsalable and must be sent offsite for disposal, the DRMO is the "generator" of that waste.

Sources of Hazardous Waste at Fort Riley

Hazardous wastes from the DRMO facility at Fort Riley are picked up by a contractor to be taken offsite to their final disposal or treatment site. Thus, the DRMO provides disposal service for the installation and is an operator of its storage site, while the Post Commander is the owner of the site. A subcontractor reporting to DRMO fills out the manifests, but DRMO personnel have the responsibility to ensure that the manifest is correct and may sign the manifest as the owner's agent. Most of the hazardous property turned in to the DRMO at Fort Riley is obtained from the following activities:

- Directorate of Industrial Operations (DIO)
- Directorate of Engineering and Housing (DEH)
- Ist Infantry Division (MECH) and Supporting Units

TABLE 2. HAZARDOUS WASTE GENERATION AT FT. RILEY IN 1988

Waste Description	Approx. Amount	Source (Building #)	Activity Generating Waste
Lead Battery Solution	7200 gal/yr	8100	DOL, Battery Shop and Kansas National Guard
Paint Solvents	300 gal/yr	8100	DOL, Auto Body and Furniture Shop
		7753	DPCA, Auto Craft Shop
		1460	KSARNG, Mates Shop
Halogenated Solvent Filters	600 gal/yr	229	DOL, Dry Cleaning Plant
Halogenated Solvent Sludge	300 gal/yr	229	DOL, Dry Cleaning Plant
Bead Blaster Dust	1.5 gal/yr	8100, 7753	DPCA, Auto Craft
Spray Paint Air	600 gal/yr	8100, 7753	DOL, DPCA, Kansas National Filters Guard Shops
		1460	
Halogenated Solvent	12 gal/yr	8100	DOL, Oil Lab
Fuel Filters	300 gal/yr	8314	DEH, POL Facility
Nickel-Cadmium Battery	24 gal/yr	727	DOL, Aviation Maint. Shop Waste
PCBs	Varies	343	DEH
Pesticide	Varies	5205	DPCA, DEH
Thiosulfate	3 gal/yr	6918	DPCA, Arts & Crafts Activity Area
Photographic Solutions	1200 gal/yr	263	DPTM, Photo Lab
Unexploded Ordnance	10 ton/yr	Range	74th ORD DET
Ordnance Residue	600 gal/yr	Range	74th ORD DET
Laboratory Chemicals	Varies	600	IACH
Mercury	Varies	1020	DEH, Natural Resource
Adhesives, Sealants	Varies		Unknown (Abandoned)
Carburetor Solvent	Varies	8100	DOL
		332	DOL, Fuel-Elec. Shop
		1460	DEH, MATES, 1st Maint. Co.
		8830	ECS33, 701 Maint.
		7920	
		1470	
Paint and Paint-Related Materials	Varies	336, 338, 343	DEH, Carpentry Shop
		8100	DOL, Maint. Shop
		7753	DPCA, Auto Craft Shop
		1460	Kansas National Guard MATES Shop
Caustic Solution	Varies	8100	DOL, Maint. Shop
		7753	DPCA, Auto Craft Shop
Sulfuric Acid	2 gal/yr	8130	Sewage Treatment Lab, Custer Hill

- Irwin Army Community Hospital (IACH)
- Kansas Army National Guard (KARNG)
- Directorate of Logistics (DOL)
- Directorate of Information Management (DOIM)
- Directorate of Personal and Community Activity (DPCA)

Two hazardous property storage and handling facilities are in operation at the DRMO location in Fort Riley.

Hazardous Waste Handling Procedure

DOD has issued specific regulations that govern the transfer of hazardous wastes and are applicable to all generators of hazardous wastes that transfer such wastes. These regulations require that agencies desiring to transfer hazardous wastes properly identify the property so that the hazardous characteristics of the waste may be immediately determined by the receiving storage facility. Each different waste must be accompanied by a completed Turn-in Document (DD Form 1348-1, Figure 3) that includes a proper item identification and a manifest. The DOD regulations state that proper identification of hazardous waste identified by a National Stock Number (NSN), will include the following information:

(a) The noun name, as catalogued in the DOD Supply System;

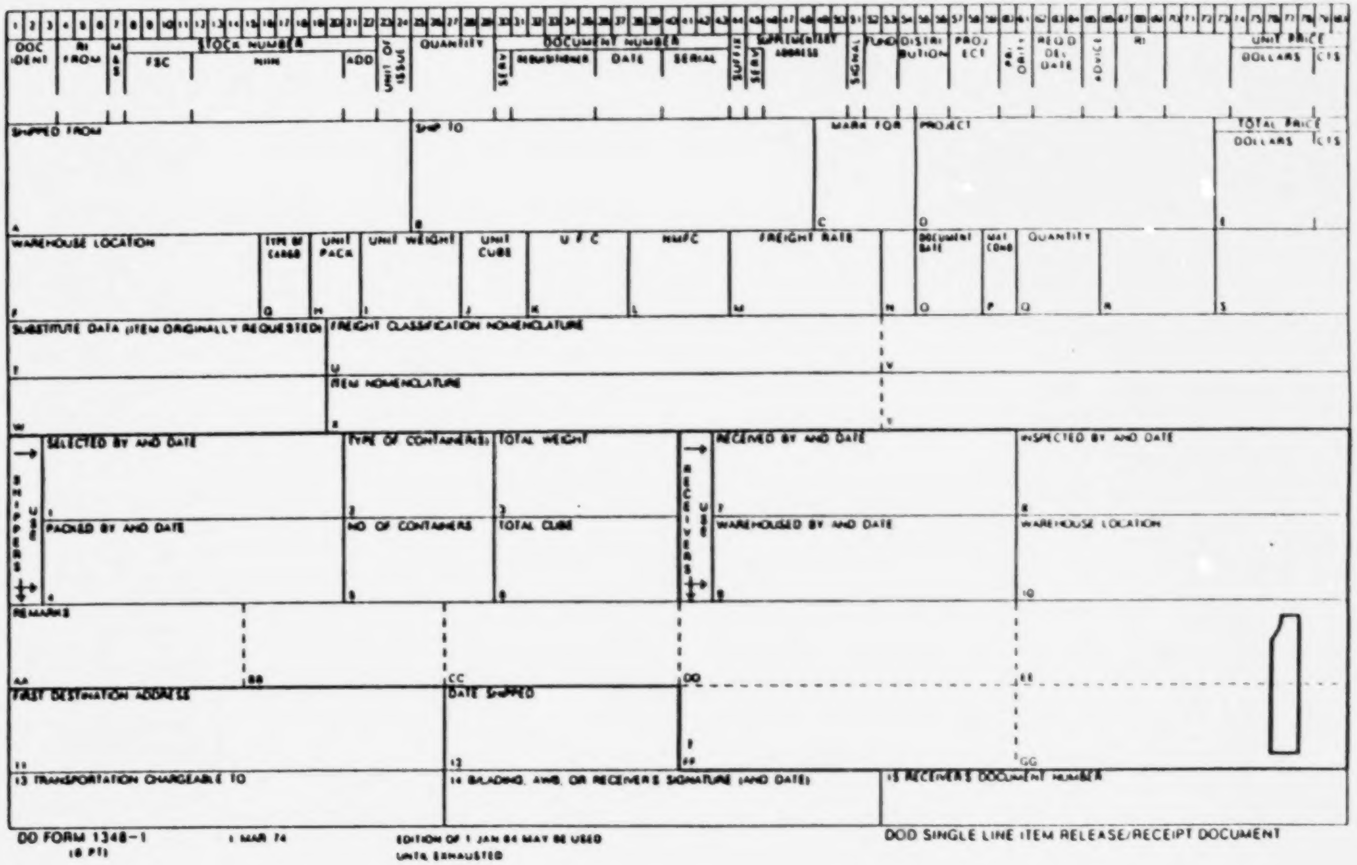
(b) The chemical names of the hazardous contaminants and the noun name of nonhazardous contaminants; and

(c) The amount of hazardous and nonhazardous contaminants based on the user's knowledge or testing of the item expressed in a range of content by percentage of parts per million as applicable.

Using the NSN, DRMO Riley will then determine the hazardous characteristics of the waste item by accessing DOD's Hazardous Materials Information System (HMIS). The HMIS is a centralized source of information that enables the cross-reference of an NSN with chemical characteristics information such as flash point, specific gravity, special handling precautions, and the hazardous ingredients contained within the NSN item. Therefore, using this information, supplemented by data from standard chemical references sources and contact with the manufacturer when necessary, DRMO will immediately be able to determine the hazardous characteristics and handling and storage protocol for an NSN item without performing a laboratory analysis.

Packaging and Movement of Hazardous Wastes at Fort Riley

Most of the containers of hazardous wastes are 55-gallon or 35-gallon metal drums or 15-gallon and 5-gallon plastic drums. Other common types of containers are the original containers in which the items were sold. Types of containers may include, but are not restricted to, metal drums, fiber drums, barrels, kegs, bags, multiwall paper, polyethylene (PE) film, corrugated cartons, bulk boxes, carboys, plastic drums, bottles, cans, pails,



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PROJECT D
TOTAL PRICE
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CTS E

WAREHOUSE LOCATION F
TYPE OF CARGO G
UNIT PACK H
UNIT WEIGHT I
UNIT CUBE J
U F C K
NMFC L
FREIGHT RATE M
N
DOCUMENT DATE O
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SUBSTITUTE DATA (ITEM ORIGINALLY REQUESTED) T
FREIGHT CLASSIFICATION NOMENCLATURE U
V
W
ITEM NOMENCLATURE X
Y

SHIPPERS USE
SELECTED BY AND DATE 1
TYPE OF CONTAINER(S) 2
TOTAL WEIGHT 3
PACKED BY AND DATE 4
NO OF CONTAINERS 5
TOTAL CUBE 6

RECEIVERS USE
RECEIVED BY AND DATE 7
INSPECTED BY AND DATE 8
WAREHOUSED BY AND DATE 9
WAREHOUSE LOCATION 10

REMARKS AA
BB
CC
DD
EE
FIRST DESTINATION ADDRESS 11
DATE SHIPPED 12
FF
GG
13 TRANSPORTATION CHARGEABLE TO
14 B/LADING, AWB, OR RECEIVER'S SIGNATURE (AND DATE)
15 RECEIVER'S DOCUMENT NUMBER

DD FORM 1348-1
(8 PT)
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EDITION OF 1 JAN 64 MAY BE USED
UNTIL EXHAUSTED
DOD SINGLE LINE ITEM RELEASE/RECEIPT DOCUMENT

Figure 3. Example of the Turn-in Document for Generators of Hazardous Materials and Hazardous Waste.

and wrap materials. All wastes are compatible with their respective containers. Containers are marked according to DPDS Manual 6050.1 (published April 1985 and revised with periodic insertions), which cross-references Department of Transportation (DOT) regulations. All containers meet DOT specifications when removed for offsite disposal as required by 40 CFR 262.30, and are prepared for transportation in accordance with 40 CFR 262.31 and 40 CFR 262.32.

The hazardous wastes under study are moved from Building 8100 in one of two ways:

- Drummed, classified as Group II wastes and sent by truck to the DRMO hazardous waste storage facility (waste battery acid in 15-gallon plastic drums and caustic cleaners in 55-gallon metal drums).

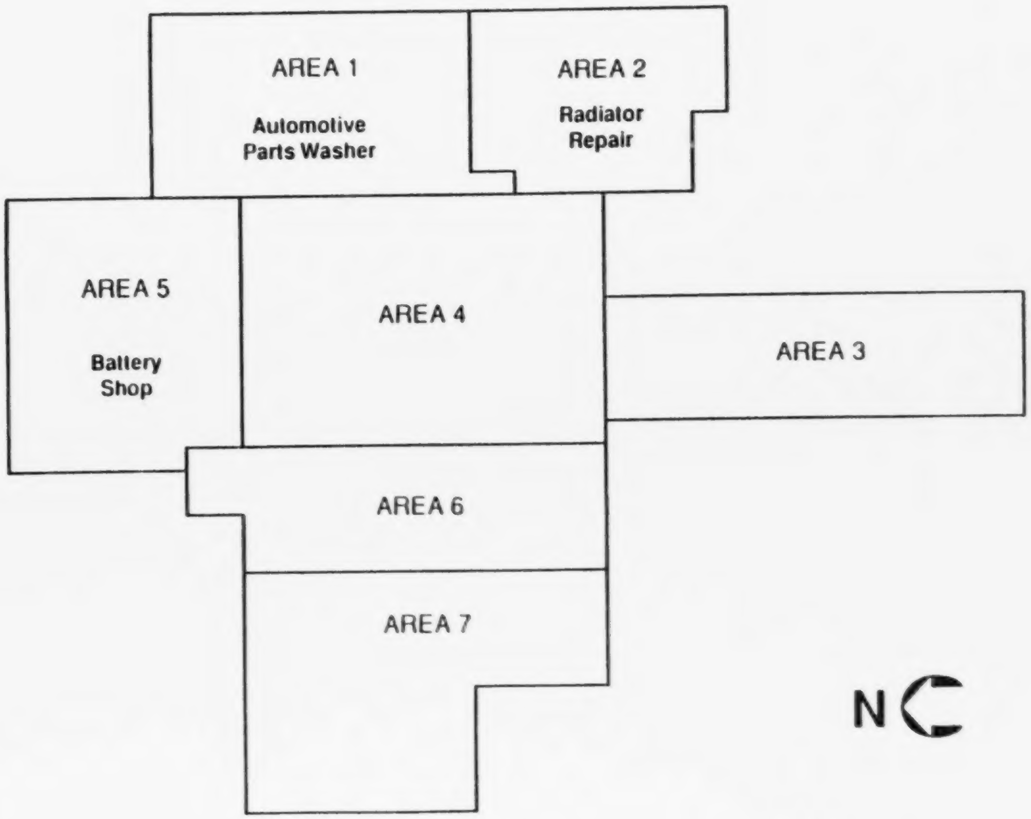
- Discharged to the onsite nonhazardous waste evaporation pond system, e.g., the automotive parts washer wastewater. This waste is currently not being handled as hazardous, but will eventually be reclassified as D002 waste (because of its alkalinity) and D008 waste (because of its lead content) under existing RCRA regulations.

DESCRIPTION OF OPERATIONS SELECTED FOR THE WASTE MINIMIZATION ASSESSMENT

Figure 4 is a simplified schematic of Building 8100, showing the location of the areas where those industrial activities are pursued that result in the generation of the hazardous wastes under study in this assessment. Referring to Figure 4, Area 5 contains, among other activities, the battery repair and service shop, which generates waste battery acid. Area 1, the automotive subassembly rebuild area, contains the automotive parts cleaning operation, which generates waste automotive wash water. Area 2 contains, among other activities, the radiator repair shop where spent caustic cleaner is periodically disposed of as a hazardous waste.

Building 8100, Area 5, Battery Repair Shop

The automotive battery repair service operation is shown in simplified schematic form in Figure 5. In the battery service shop, about 7,200 gallons per year of battery acid are drained before battery repair or disposal is carried out. Batteries are conveyed to a trough where they are inverted and drained. The drained batteries are then either disposed of (if determined to be unusable) or repaired (battery terminals replaced) and refilled with fresh 37 percent sulfuric acid, recharged to operational amperage and placed back in operation. The drained waste battery acid is pumped into 15-gallon plastic drums (placed back in the same drums in which the virgin acid is shipped to the facility). A pallet of 8- to 15-gallon drums is shipped along with a turn-in ticket (see Figure 3) to the Fort Riley DRMO hazardous waste storage facility, where the material is stored until final disposal to a hazardous waste contractor.


AREA 1
Automotive Parts Washer
AREA 2
Radiator Repair
AREA 3
AREA 4
AREA 5
Battery Shop
AREA 6
AREA 7
N

AREA 1– **Automotive Subassembly Rebuild**

AREA 2– Machine Shop, Glass, Paint, Washrack, **Radiator Repair**

AREA 3– Inspection and End Item Repair

AREA 4– Bulk Storage

AREA 5– DX, **Battery Shop**, Office Machines, Target Motors, Fire Extinguishers, Generators, Receiving

AREA 6– Comm El, Missile, Crypto, Photo, Canvas, Locksmith, Production Control

AREA 7– Offices, Conference/ Training Room, Library, Upholstery, Furniture, Calibration

Figure 4. Simplified Schematic of Building 8100.

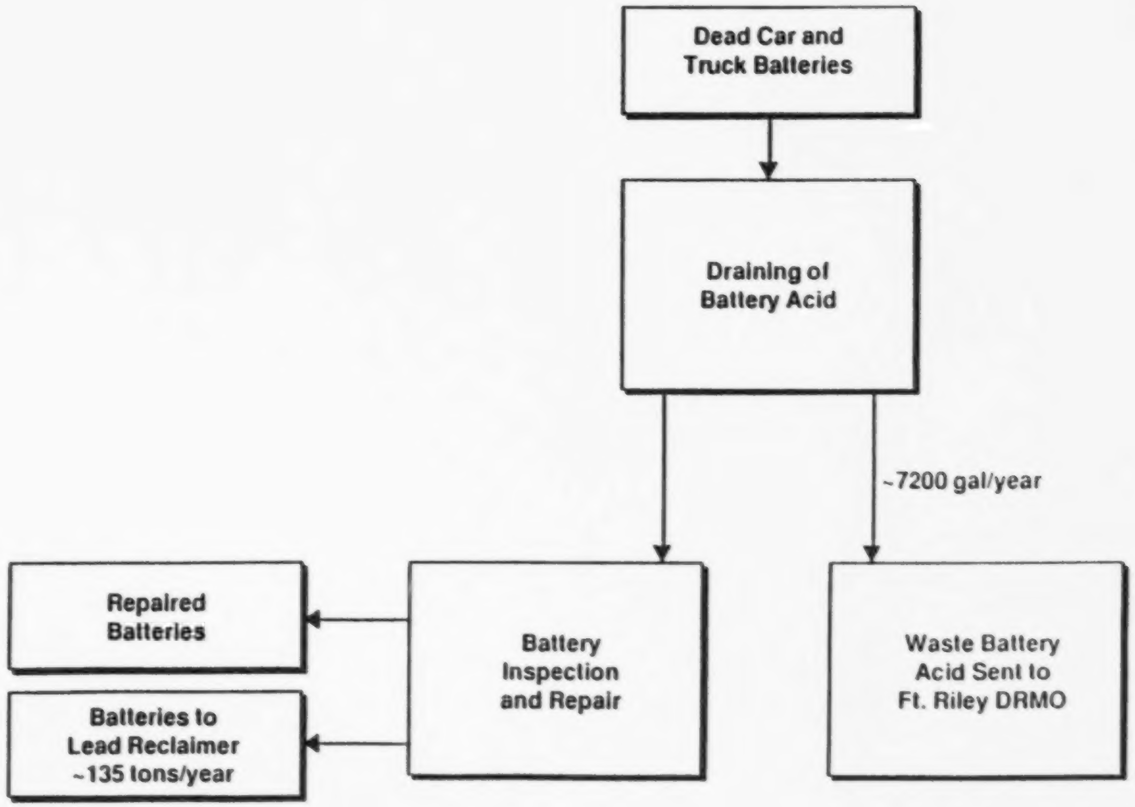

Dead Car and Truck Batteries
Draining of Battery Acid
~7200 gal/year
Battery Inspection and Repair
Waste Battery Acid Sent to Ft. Riley DRMO
Repaired Batteries
Batteries to Lead Reclaimer ~135 tons/year

Figure 5. Block Flow Diagram, Battery Shop Operation Building 8100.

The salient operational facts on the battery shop operation gathered by the assessment team during the detailed site inspection are tabulated in Table 3. The assessment team collected samples of spent and virgin acids for later analytical work at Versar's laboratory.

Building 8100, Area 1, Automotive Subassembly Rebuild (Automotive Parts Washing)

Prior to rebuilding various automotive subassemblies, e.g., engines, clutches, transmissions, these units are disassembled and placed in a specially designed high pressure hot-water washer to be thoroughly cleaned. The batch washer, manufactured by the MART Corporation of St. Louis, Missouri, is designed to operate on a half-hour to one-hour cycle, using the washing action of pressurized hot alkaline detergent solution to remove oil, grime, dirt, grease, and carbonized material from the surfaces of automotive parts. The MART unit has the following specifications:

Tornado Washer Model No. 84
Wash Water Capacity: 580 gallons/batch
Operational pH: 10
Typical Alkaline Cleaner: Oakite 100, Guardian
Recommended Alkaline Cleaner Composition: 60% caustic, 30% sodium glutamate, 10% rust inhibitor, and small quantities of chelants and surfactants
Recommended Alkaline Cleaner Concentration: 4-8 oz/gal
Washer Cycle: 1 hour

The automotive parts washing operation is shown in simplified schematic form in Figure 6. The Tornado washer unit continuously circulates 430 gpm of hot alkaline solution through high-pressure jets to provide the cleaning action. An initial 580-gallon charge is run for 5 days (fresh solution is made up Monday morning, with spent solution drained from the unit on Friday evening). Tramp oils are decanted, and sludge is manually scrapped from the unit following draining of the bulk of the spent solution to the onsite evaporation pond system. The latter system is designed to hold nonhazardous drainage from the various onsite Army motor pool washing operations and is not designed according to RCRA hazardous waste storage requirements. However, the Tornado washer wastewater is considered RCRA D007 and D008 waste because of its chromium and lead content (>5mg/liter). Thus, it will eventually require a change in disposal method in order to fulfill RCRA requirements.

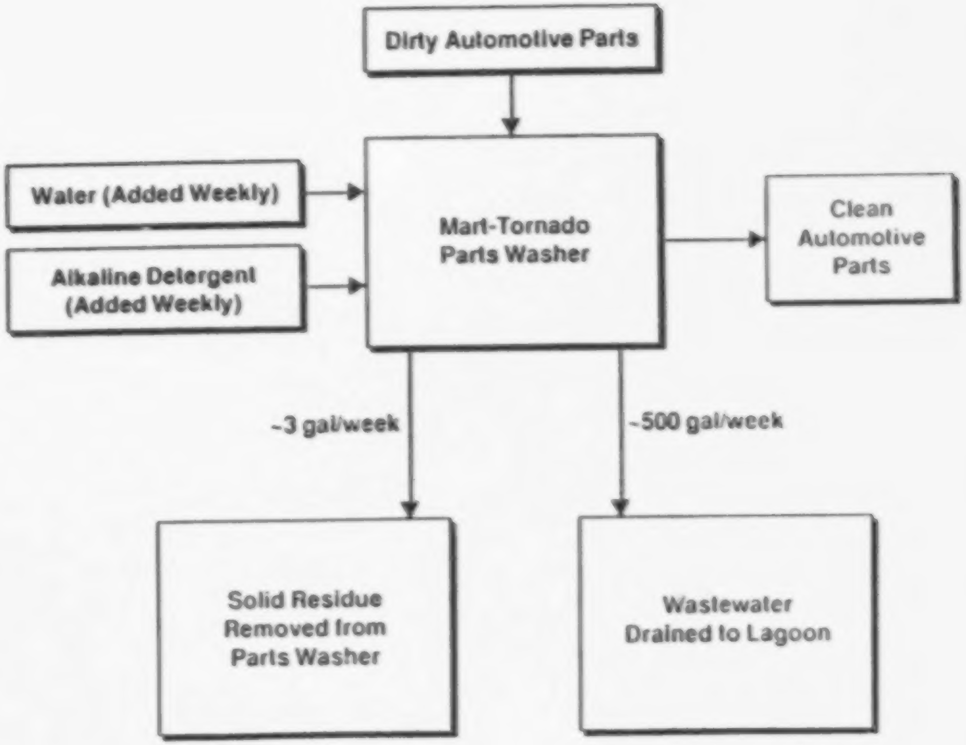

Dirty Automotive Parts
Water (Added Weekly)
Alkaline Detergent (Added Weekly)
Mart-Tornado Parts Washer
Clean Automotive Parts
~3 gal/week
~500 gal/week
Solid Residue Removed from Parts Washer
Wastewater Drained to Lagoon

Figure 6. Simplified Schematic, Automotive Parts Cleaning in Building 8100.

TABLE 3. PERTINENT OPERATIONAL DATA OBTAINED AT THE FORT RILEY BATTERY REPAIR SHOP (BUILDING 8100, AREA 5)

Total Waste Battery Acid Generated:	7200 gal/yr
Waste Sulfuric Acid Strength (D002 waste):	32 percent (average)
Virgin Sulfuric Acid Strength:	37 percent
Total Waste Batteries Generated:	approximately $3,500/yr
DRMO Disposal Cost for Waste Battery Acid:	approximately $28,000/yr
Heavy Metal Contaminants in Waste Battery Acid:	
Cadmium	15 to 20 mg/L
Lead	1 to 3.4mg/L

SECTION 3

ASSESSMENT PHASE RESULTS

SUMMARY OF ASSESSMENT PHASE

The assessment phase includes data collection, selection of target areas, data review, and options generating and screening. The results of the assessment phase for the two waste streams studied are contained in Worksheets 2 through 13 (Appendices A, and B) for these two waste streams, respectively:

(a) Waste battery acid; and

(b) Tornado parts washer wastewater.

These results are summarized in Table 4.

Table 4 lists the two individual waste streams studied during the assessment and includes the building in which they originate at Fort Riley, as well as the associated operations that generate the wastes. Table 4 also lists some key data for each waste stream, including:

- The estimated volume generated in 1988,
- The hazardous characteristics of the waste,
- The estimated annual disposal cost in 1988,
- The raw materials costs for input materials that are considered at least partially recoverable, and
- The WM options that were considered in the screening step.

The WM option screening process (as described in the EPA WM manual) would ordinarily consist of a relative comparison of WM options described on worksheet 12. However, for waste streams, (a) and (b), only one waste minimization approach, i.e., recycling, as defined in the EPA hierarchy of WM options, is available, and there was thus no need to develop relative WM scores.

DESCRIPTION OF WASTE MINIMIZATION OPTION FOR WASTE BATTERY ACID

In the Building 8100 battery repair shop, about 7,200 gallons of battery acid per year are drained from batteries that cannot be charged or that require rebuilding of battery parts.

The waste acid is collected in a trough and pumped into 15-gallon plastic drums (the same drums in which the virgin battery acid is currently received), which are then palletized, moved by truck to the DRMO storage area at Fort Riley, and ultimately disposed of to a hazardous waste disposal contractor.

TABLE 4. SUMMARY OF WASTE MINIMIZATION ASSESSMENT PHASE

Location/Operation/Waste Stream	Volume (GPY)	RCRA Characteristics	Costs ($/yr)	Disposal Costs ($/yr)	WM Options
Building 8100					
Battery Repair Shop/Waste Battery Acid	7,200	Corrosive (D002), Toxic metals (D006, D008)	$27,900	$11,530	Recycle of waste battery acid
Building 8100					
Automotive Subassembly Rebuild/ Tornado Parts Washer Wastewater	29,000	Toxic Metals (D007, D008)	$112,000[a]	--	Recycle of Tornado parts washer wastewater water

[a] Based on disposal of this stream as a hazardous waste by DRMO at an assumed cost of $4/gallon. This cost is approximately that currently being paid by DRMO for disposal of corrosive waste. This waste is presently being disposed of to an onsite nonhazardous waste evaporative pond system.

Recycle of Waste Battery Acid

Referring to Figure 7, waste battery acid is recycled for reuse in the battery repair shop. In this option, an approximately 140-gallon batch of waste battery acid collected weekly in the battery repair shop is pumped from the 15-gallon (or 55-gallon) storage drums into the acid resistant tank TK-1. After the batch is thoroughly mixed using the recirculating pump, a sample is taken and checked for specific gravity. Based on the specific gravity reading, sufficient strong sulfuric acid (60° Baume acid 78% H_2SO_4) is manually pumped into the tank (with continuous circulating pump action) to bring acid strength up to 37-38 percent H_2SO_4 normal battery acid strength. The refortified acid batch is pumped thorough the acid resistant filter to remove any tramp particulates present and then is collected in the 15- or 55-gallon storage drums for use in the battery shop repair operation. At suitable intervals (to be determined by field experience with the recharged batteries), a 140-gallon batch of waste battery acid is neutralized (as described in Section 3.2) to minimize buildup of undesirable dissolved impurities in the acid and discarded. It should be noted that 78% sulfuric acid (60° Baume) is used for refortification rather than 93%-98% acid (66° Baume) because the heat evolution on mixing with the stronger acid dictates the installation of an expensive acid-resistent cooler; this cost can be avoided by the use of the weaker acid.

The technical feasibility of this option is discussed in Section 4.

DESCRIPTION OF WASTE MINIMIZATION OPTION FOR THE TORNADO WASHER WASTEWATER

The Tornado parts washer is used in the Building 8100 Automotive Subassembly Rebuild Area to remove oils, dirt, grease, and other soils adhering to engine parts, transmissions, rear ends, etc., received from Army vehicles prior to repairing or rebuilding.[a] The Tornado parts washer generates about 580 gallons of wastewater per week, which is drained at the end of the workweek to the industrial sewer. Tramp oils and sludge are collected in plastic bags (approximately 3 gallons per week) and disposed of in the general Fort Riley trash. The wastewater is known to be high alkaline (pH-13) and contains dissolved metals--principally lead and chromium in excess of the EP-toxicity levels for these RCRA hazardous wastes. The Fort Riley DEH personnel are aware of the hazardous nature of this wastewater and have indicated to the assessment team that the present disposal method-draining to an onsite nonhazardous waste evaporation lagoon system, will have to be stopped and the material handled as a RCRA hazardous waste. The WM option, developed by the assessment team and discussed below, takes this into account.

---

[a] This washer is produced by MART, Inc., St. Louis, Missouri, and is the company's brand name.

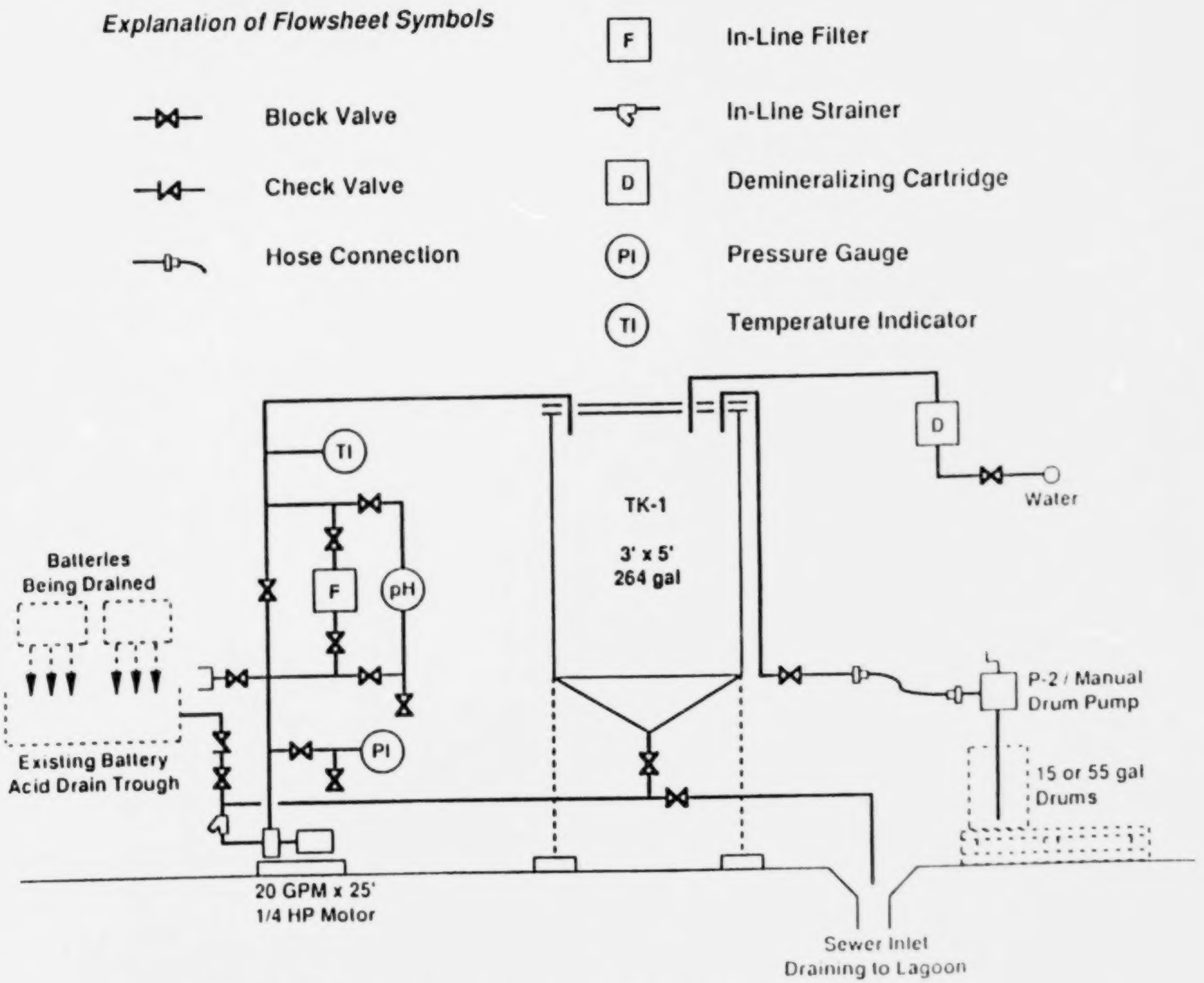

Explanation of Flowsheet Symbols
Block Valve
Check Valve
Hose Connection
F
In-Line Filter
In-Line Strainer
D
Demineralizing Cartridge
PI
Pressure Gauge
TI
Temperature Indicator
TI
F
pH
PI
Batteries
Being Drained
Existing Battery
Acid Drain Trough
20 GPM x 25'
1/4 HP Motor
TK-1
3' x 5'
264 gal
D
Water
P-2 / Manual
Drum Pump
15 or 55 gal
Drums
Sewer Inlet
Draining to Lagoon

Figure 7. Proposed Equipment for Waste Battery Acid Option.

Recirculation of Tornado Washer Wastewater Following Cleanup - Tornado Washer Wastewater Option 1

The Tornado Parts Washer Wastewater waste minimization system is shown in Figure 8. This system includes a polypropylene tank TK-1, into which the 580-gallon batch of Tornado washer wastewater is pumped at the end of the workweek. In this option, the wastewater instead of being disposed of as hazardous waste, would be recycled to the Tornado washer following filtration in an in-line filter to remove discrete particulates entrained in the washwater, and de-emulsifica-tion, a process carried out in tank TK-1 by which small quantities of emulsified oils in the wash water are separated through the addition of an appropriate de-emulsifying agent. After suitable mixing (as provided by the circulating pump), the oils are allowed to float to the top of the water phase in tank TK-1 and are skimmed off by hand. Additional detergent is added to the tank contents as needed, and the water is then recycled to the Tornado parts washer. It is not known at this time what type of filter element is most suitable for this operation, whether such filter elements will be clogged by suspended grease, tar or oil globules, whether multiple filters are needed, etc. Detailed conversations with filter vendors and field testing of this approach-efforts beyond the scope of the present effort, will be required when this option is studied further at Fort Riley.

The technical feasibility of the recycling of Tornado Parts Washer Wastewater is more fully discussed in Section 4.

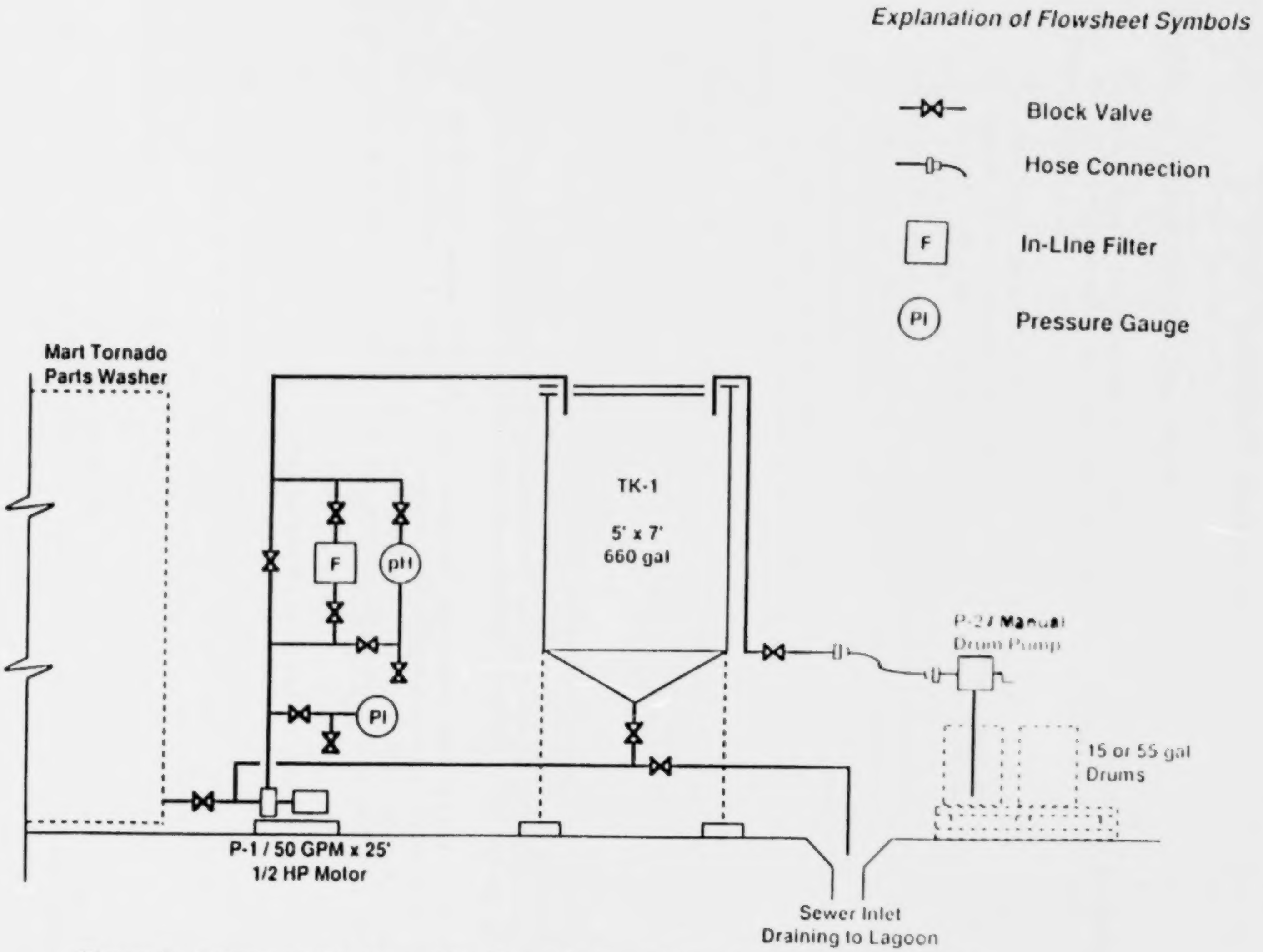

Explanation of Flowsheet Symbols
Block Valve
Hose Connection
F
In-Line Filter
PI
Pressure Gauge
Mart Tornado Parts Washer
F
pH
PI
P-1 / 50 GPM x 25' 1/2 HP Motor
TK-1
5' x 7' 660 gal
P-2 / Manual Drum Pump
15 or 55 gal Drums
Sewer Inlet Draining to Lagoon

Figure 8. Proposed Equipment for Tornado Parts Washer Wastewater Option.

SECTION 4

FEASIBILITY ANALYSIS RESULTS

SUMMARY OF FEASIBILITY ANALYSIS PHASE

The purpose of the feasibility analysis phase is to prepare a technical and economic evaluation of the WM options and to select options for implementation.

The technical feasibility evaluation initially determines the nature of the WM option, i.e., whether it is equipment-related, personnel/procedure-related, or materials-related or a combination of these factors. For each of the three types of WM options, specific information and data are required. For equipment-related options, the information requirements relate to the state of technology, availability of equipment, performance specifications, testing, space and utilities, production effects, and training. For personnel/procedure-related options, the required information relates to training and operating instruction changes. For materials-related options, the required information relates to production impacts, storage and handling, training, and testing.

The two WM options evaluated during this project are considered to be combinations of equipment, personnel/procedure, and materials-related options. The technical evaluation for these options is detailed on Worksheets 14a and 14b, Appendices A and B.

The economic feasibility evaluation includes a preliminary cost analysis of both capital and operating costs. Capital costs include preliminary order of magnitude estimates of equipment, materials, utility connections, site preparation, installation, engineering, permitting, startup, and training.

The operating costs include estimates of increases and decreases (cost savings) of utilities, disposal fees, raw materials, and labor. Insurance and liabilities costs were not included in the operating cost calculation, since these costs were undetermined during the project. Also, onsite handling costs were not included.

Data on order-of-magnitude capital costs as well as "ball-park" estimates of operating costs (except for known chemical costs) are presented in Worksheets 15a-f, Appendix A for the waste battery acid recycle option, and in Worksheets 15a-f, Appendix B for the washer wastewater recycle option.

RECOMMENDATIONS

The technical and economic results of the feasibility analysis phase are summarized in Tables 5 and 6. Table 5 summarizes, for each of the two waste minimization options studied, the salient factors that appear to make these options technically feasible. Table 6 indicates, the total capital

TABLE 5. SUMMARY OF FACTORS DETERMINING TECHNICAL FEASIBILITY OF FIVE WM OPTIONS STUDIED

Option No.	Source of Waste	Description of WM Option	Principal Factors Involved in Evaluating Technical Feasibility of Proposed Option
Waste Battery Acid Option	Building 8100, Battery Repair Shop	Recycle of waste battery acid after refortification with strong acid	1) As long as iron and copper are not present in waste acid, this acid can be recycled for battery use, following refortification with strong acid.[a] 2) Adequate testing of the performance of the recycled acid can be performed within the existing battery shop operation.
Tornado Parts Washer Wastewater Option	Building 8100, Automotive Subassembly Rebuild Area, Tornado Parts Washer	Recycle of Tornado parts washer wastewater following cleanup operation	1) Tornado washer manufacturer states that wash water, if periodically denuded of emulsified oils, can be reused indefinitely.[b] However, a more conservative approach consists of purge and neutralization of wastewater batches (done at appropriate intervals to prevent impurities buildup) followed by sewering of the purged, neutralized washwater.

NOTES:

a. Personal Communication, Mr. T. Post, Exide Corp., Reading, Pa., to Dr. M. Drabkin, Versar, September 5, 1989.

b. Personal Communication, Mr. G. Minken, MART Corp., St. Louis, Mo., to Dr. M. Drabkin, Versar, August 25, 1989.

TABLE 6. SUMMARY OF WASTE MINIMIZATION OPTIONS COST ANALYSIS DATA

Location/Operation/Waste Stream	Waste Minimization Options	Total Capital Investment, $	Net Operating Cost Savings, $	Payback Period, Years
Building 8100/ Battery Repair Shop/ Waste Battery Acid	Recycle of waste battery acid	15,200	37,400	0.41
Building 8100/ Automotive Subassembly Rebuild/ Tornado Parts Washer Wastewater	Recycle of Tornado washer wastewater	19,800	112,000	0.18

investment, the net operating cost savings, and the payback period (total capital investment/net operating cost savings).

A review of Table 6 indicates that the waste battery acid recycle option is clearly more attractive than disposal of the acid via DRMO. From a technical feasibility standpoint, however, adequate testing of the refortified, recycled acid would have to be carried out to ensure that this material does not adversely affect battery operation.

With regard to the Tornado parts washer wastewater, the recycled wash water (following cleanup) would have to be monitored for adequate detergency in the Tornado unit. It should be noted that the proposed procedure of filtering out particulates, and de-emulsifying and skimming of floating oils, has not been demonstrated. There is a need for in-plant experimentation to determine what type of filter elements work best, whether multiple filters are needed, how effective the recycled wash water is in cleaning automotive parts, etc. To reflect this uncertainty, a 25% contingency was added to the capital cost estimate for this waste minimization option.

The implementation of both sets of options would cost about $35,000. Annual operating cost savings to Fort Riley would be about $149,000 if recycle of both wastes were instituted. Payback periods for simultaneous implementation of both recycle options would be less than 5 months.

APPENDIX A

WASTE MINIMIZATION ASSESSMENT WORKSHEETS
BUILDING 8100 BATTERY REPAIR SHOP

Firm *U.S. Army FORSCOM*	**Waste Minimization Assessment**	Prepared By ________
Site *Fort Riley, Kansas*		Checked By ________
Date *9/30.89*	Proj. No. ________	Sheet *1* of *1* Page __ of __

WORKSHEET 2

PROGRAM ORGANIZATION

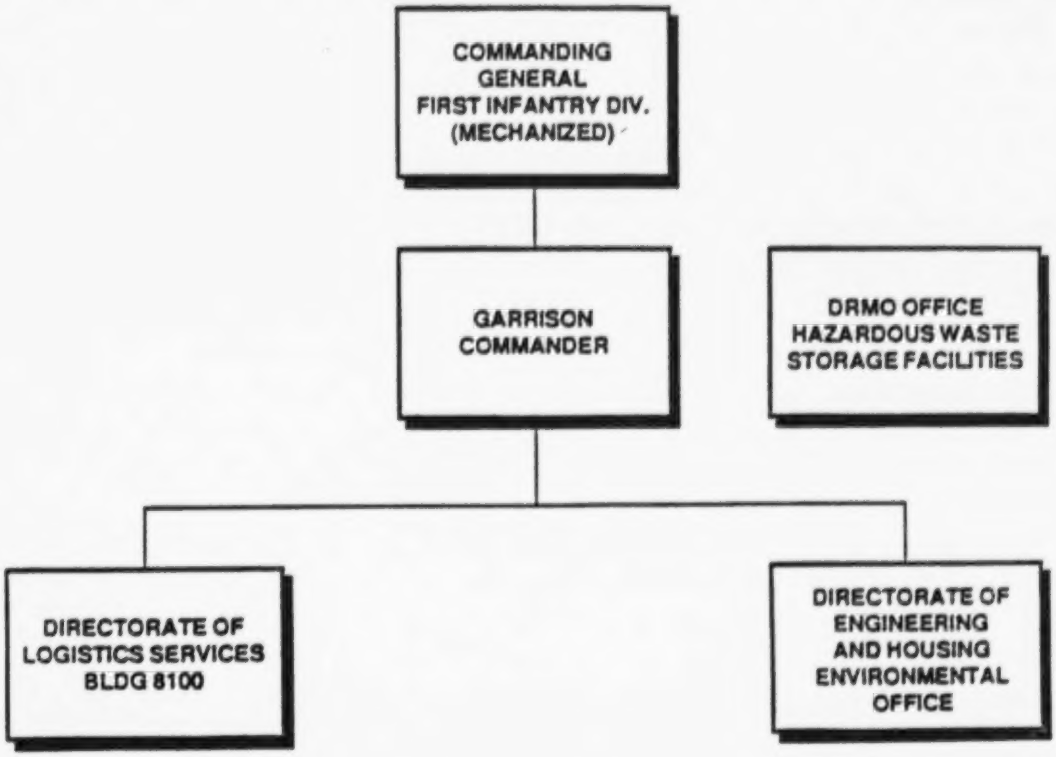
EPA

FUNCTION	NAME	LOCATION	TELEPHONE #
EPA Project Manager	Jim Bridges	EPA/ORD, Cincinnati, OH	513-569-7683
Site Coordinator	Charles Harris	Bldg. 133, Ft. Riley	913-239-3962
Assessment Team Leader	Marvin Drabkin	Versar Inc., Springfield, VA	703-750-3000

Organization Chart

(sketch)

FORT RILEY, KANSAS – PARTIAL ORGANIZATION CHART


COMMANDING GENERAL FIRST INFANTRY DIV. (MECHANIZED)
GARRISON COMMANDER
DRMO OFFICE HAZARDOUS WASTE STORAGE FACILITIES
DIRECTORATE OF LOGISTICS SERVICES BLDG 8100
DIRECTORATE OF ENGINEERING AND HOUSING ENVIRONMENTAL OFFICE

Firm Versar/U.S. Army
Site Ft. Riley, Kansas
Date 9/30/89

Waste Minimization Assessment

Proj. No. ____

Prepared By ____
Checked By ____
Sheet 1 of 1 Page __ of __

WORKSHEET
3

ASSESSMENT TEAM MAKE-UP

EPA

Function/Department	Name	Location/ Telephone #	Manhours Required	Duties		
				Lead	Support	Review
Assessment Team						
Leader	Marvin Drabkin	(703) 750-3000				
Site Coordinator	Charles Harris	(913) 239-3962				
Operations	Milton McCabe	(913) 239-5235				
Engineering	Adolf Gessner	(703) 750-3000				
Maintenance						
Scheduling						
Materials Control						
Procurement						
Shipping/Receiving						
Facilities						
Quality Control						
Environmental	Max Diaz	(703) 750-3000				
Accounting						
Personnel						
R & D						
Legal						
Management						
Contractor/Consultant						
Safety						

Firm U.S. Army/FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas		Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 4

SITE DESCRIPTION

EPA

Firm: U.S. Army FORSCOM

Plant: Ft. Riley, Custer Hill Area

Department: DOL/EC Services

Area: Lead-Acid Battery Repair Shop

Street Address: Bldg. 8100

City: Ft. Riley

State/ZIP Code: Kansas 66442-5220

Telephone: (913) 239-5235

Major ~~Products~~: Services: Servicing and repair of U.S. Army 1st Infantry Division (Mechanized) lead-acid storage batteries used in Division vehicles

SIC Codes: 9711/7629

EPA Generator Number : KS 6214020756

Major Unit or:

Product or:

Operations: Sulfuric acid (s.g. 1.24) is drained from batteries, drummed up, and sent to DRMO for disposal. Shop operates one shift per day, 5 days per week, 2 employees. Waste generated is RCRA D002, D006, D008.

Facilities/Equipment Age: Shop in operation about 10 years.

Firm U.S. Army/ FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Fort Riley, Kansas		Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 5

PERSONNEL

EPA

Attribute	Overall	Department/Area			
Total Staff					
Direct Supv. Staff					
Management					
Average Age, yrs.					
Annual Turnover Rate %					
Seniority, yrs.					
Yrs. of Formal Education					
Training, hrs./yr.					
Additional Remarks					

N/A

Firm U.S. Army/ FORSCOM Site Ft. Riley, Kansas Date 9/30/89	**Waste Minimization Assessment** Proj. No. ____________	Prepared By ____________ Checked By ____________ Sheet 1 of 1 Page __ of __

WORKSHEET 6

PROCESS INFORMATION

Process Unit/Operation: Battery Repair Shop

Operation Type: ☐ Continuous ☐ Discrete

☒ Batch or Semi-Batch ☐ Other ____________

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N	N		N		
Material/Energy Balance	N	N		N		
Design						
Operating						
Flow/Amount Measurements						
Stream						
Waste battery acid	Y	Y		Y		
Analyses/Assays						
Stream						
Waste battery acid	Y	N		Y		
Process Description	Y	Y		Y		
Operating Manuals	N	N				
Equipment List	N	N				
Equipment Specifications	N	N				
Piping & Instrument Diagrams	N	N				
Plot and Elevation Plan(s)	N	N				
Work Flow Diagrams	N	N				
Hazardous Waste Manifests	N	N				
Emission Inventories	N	N				
Annual/Biennial Reports	N	N				
Environmental Audit Reports	N	N				
Permit/Permit Applications	N	N				
Batch Sheet(s)	N	N				
Materials Application Diagrams	N	N				
Product Composition Sheets	N	N				
Material Safety Data Sheets	Y	Y		Y		
Inventory Records	N	N				
Operator Logs	N	N				
Production Schedules	N	N				

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas		Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 7

INPUT MATERIALS SUMMARY

EPA

Attribute	Description		
	Stream No. 1	**Stream No.**	**Stream No.**
Name/ID	Battery Acid		
Source/Supplier	Octagon Process		
Component/Attribute of Concern			
Annual Consumption Rate	7,200 gal		
Overall			
Component(s) of Concern	H_2SO_4, Pb, Cd		
Purchase Price, $ per gal.	1.90		
Overall Annual Cost	$13,680		
Delivery Mode[1]	Truck		
Shipping Container Size & Type[2]	15 gal. plastic drum		
Storage Mode[3]	Stored on pallets in DRMO hazardous waste storage facility at Ft. Riley		
Transfer Mode[4]	Forklift, pump		
Empty Container Disposal/Management[5]	Filled w/spent acid and sent to DRMO/Riley		
Shelf Life	N/A		
Supplier Would			
- accept expired material (Y/N)	N/A		
- accept shipping containers (Y/N)	N/A		
- revise expiration date (Y/N)	N/A		
Acceptable Substitute(s), if any	N/A		
Alternate Supplier(s)	Local acid suppliers		
	e.g., K.C., MO, or St. Louis, MO		

[1] **e.g., pipeline, tank car, 100 bbl. tank truck, truck, etc.**

[2] **e.g., 55 gal. drum, 100 lb. paper bag, tank, etc.**

[3] **e.g., outdoor, warehouse, underground, aboveground, etc.**

[4] **e.g., pump, forklift, pneumatic transport, conveyor, etc.**

[5] **e.g., crush and landfill, clean and recycle, return to supplier, etc.**

Firm U.S. Army/FORSCOM	**Waste Minimization Assessment**	Prepared By ______
Site Ft. Riley, Kansas		Checked By ______
Date 9/30/89	Proj. No. ______	Sheet 1 of 1 Page __ of __

WORKSHEET 8

PRODUCTS SUMMARY

EPA

Attribute	Description		
	Stream No. 1	Stream No.____	Stream No.____
Name/ID	N/A		
Component/Attribute of Concern			
Annual Production Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $ ______			
Shipping Mode			
Shipping Container Size & Type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
- relax specification (Y/N)			
- accept larger containers (Y/N)			

Firm U.S. Army/ FORSCOM	Waste Minimization Assessment	Prepared By
Site Ft. Riley, Kansas		Checked By
Date 9/30/89	Proj. No.	Sheet 2 of 4 Page __ of __

WORKSHEET 9a

INDIVIDUAL WASTE STREAM CHARACTERIZATION

EPA

1. **Waste Stream Name/ID:** Waste Battery Acid **Stream Number** 1
Process Unit/Operation Battery Repair Shop

2. **Waste Characteristics**

☐ gas ☒ liquid ☐ solid ☐ mixed phase

Density, lb/cuft sp. gr. 1.10 - 1.24; 69 - 77 lbs./ft^3
Viscosity/Consistency
pH <1 ,Flash Point N/A ; % Water approx. 68

3. **Waste Leaves Process as:**
☐ air emission ☐ waste water ☐ solid waste ☒ hazardous waste

4. **Occurrence**
☐ continuous
☒ discrete
discharge triggered by ☐ chemical analysis
☒ other (describe) Need to discard/repair automotive lead acid battery
Type: ☐ periodic ______ length of period: ______
☒ sporadic (irregular occurrence)
☐ non-recurrent

5. **Generation Rate**
Annual 74,400 lbs per year
Maximum ______ lbs per ______
Average ______ lbs per ______
Frequency ______ batches per ______
Batch Size ______ average ______ range

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Site Ft. Riley, Kansas	Proc. Unit/Oper. ______	Checked By ______
Date 9/30/89	Proj. No. ______	Sheet 2 of 4 Page __ of __

WORKSHEET 9b

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

6. Waste Origins/Sources

Fill out this worksheet to identify the origin of the waste. If the waste is a mixture of waste streams, fill out a sheet for each of the individual waste streams.

Is the waste mixed with other wastes? ☐ Yes ☒ No.

Check **Describe**

☐ Formulation/Removal of Undesirable Compound ______

☐ Unconverted Hazardous Raw Materials or Additive ______

☐ Accumulation of Inert Impurity ______

☐ Depletion of Key Component(s) ______

☐ Equipment Cleaning ______

☐ Obsolete Stock ______

☐ Spoiled Batch/Production Run ______

☐ Spill/Leak Cleanup ______

☐ Evaporative Loss ______

☐ Breathing/Venting Losses ______

☒ Other Sulfuric acid drained from batteries prior to the latter being repaired or discarded.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 3 of 4 Page __ of __

WORKSHEET
9c

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

Waste Stream Waste battery acid

7. **Management Method**

Leaves site in
☐ bulk
☐ roll off bins
☐ 55 gal drums
☒ other (describe) 15 gal. drums

Disposal Frequency Approximately 8-15 gallon drums per week

Applicable Regulations[1] RCRA

Regulatory Classification[2] D002, D006, D008

Managed
☐ onsite ☒ offsite
☐ commercial TSDF
☐ own TSDF
☐ other (describe)

Recycling
☐ direct use/re-use
☐ combusted for energy content
☐ redistilled
☐ other (describe)

reclaimed material returned to site?
☐ Yes ☒ No ☐ used by others
residue yield
residue disposal/repository

Note[1] list federal, state & local regulations, (e.g., RCRA, TSCA, etc.)

Note[2] list pertinent regulatory classification (e.g., RCRA - Listed K011 waste, etc.)

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 4 of 4 Page __ of __

WORKSHEET 9d

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

Waste Stream Waste Battery Acid

7. **Management Method (continued)** N/A

Treatment

☐ biological
☐ oxidation/reduction
☐ incineration
☐ pH adjustment
☐ precipitation
☐ solidification
☐ other (describe)

residue disposal/repository

Final Disposition

☐ landfill
☐ pond
☐ lagoon
☐ deep well
☐ ocean
☐ other (describe)

Costs as of ________ (quarter and year)

Cost Element:	Unit Price $ per gal	Reference/Source:
Onsite Storage & Handling		
Pretreatment		
Container		
Transportation Fee		
Disposal Fee	$3.87	Charles Harris, DEH, Ft.Riley
Local Taxes		
State Tax		
Federal Tax		
Total Disposal Cost	$3.87	

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 10

WASTE STREAM SUMMARY

EPA

Attribute	Description		
	Stream No. 1	Stream No.____	Stream No.____
Waste ID/Name:	Waste battery acid		
Source/Origin	Battery shop		
Component/or Property of Concern	H_2SO_4, Cd, Pb		
Annual Generation Rate (units gal)	7,200		
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per: gal.)	3.87		
Overall (per year)	27,900		
Method of Management[1]	DRMO ships offsite via haz-waste contractor		

Priority Rating Criteria[2] N/A	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Reduce Raw Material Cost							
Ease of Implementation							
Sum of Priority Rating Scores		$\Sigma(R \times W)$		$\Sigma(R \times W)$		$\Sigma(R \times W)$	
Priority Rank N/A							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, onsite recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.

2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET
11

OPTION GENERATION

EPA

Meeting format (e.g., brainstorming, nominal group technique) Brainstorming

Meeting Coordinator Marvin Drabkin

Meeting Participants M. Drabkin, M. Diaz, A. Wessner

List Suggested Options	Rationale/Remarks on Option
Reuse waste battery acid by filtering and then bringing up to full strength (sp.gr. 1.28, 37 wt % H_2SO_4) with 78% H_2SO_4 (60° Baume acid)	1. Reduce present disposal costs. 2. Trace metals reported in waste acid (Pb, Cd) do not affect acid performance in battery based on Federal Spec for this material. 3. This option must be tested as to its effect on battery performance.

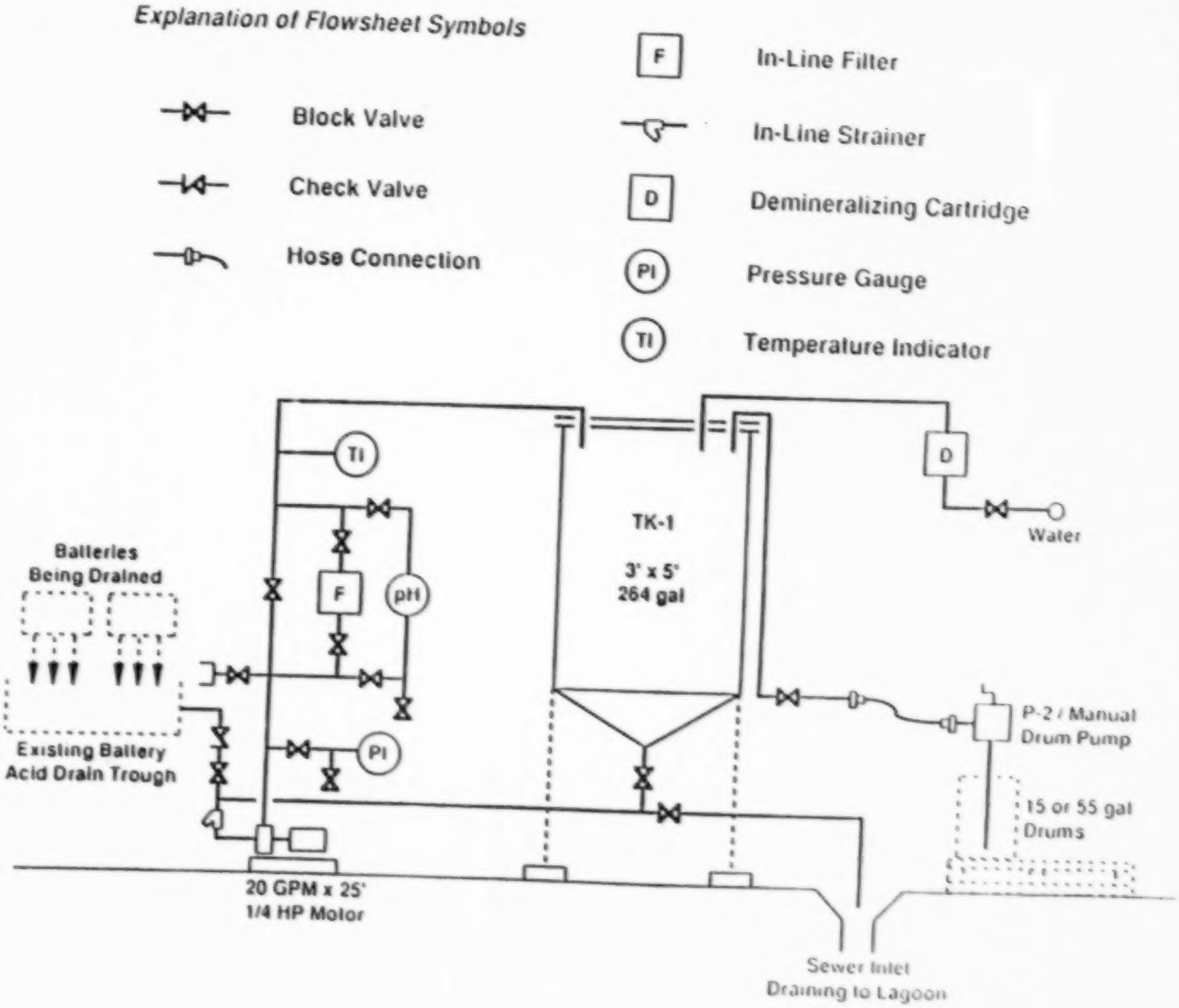

Explanation of Flowsheet Symbols
Block Valve
Check Valve
Hose Connection
F
In-Line Filter
In-Line Strainer
D
Demineralizing Cartridge
PI
Pressure Gauge
TI
Temperature Indicator
Batteries Being Drained
Existing Battery Acid Drain Trough
TI
F
pH
PI
20 GPM x 25'
1/4 HP Motor
TK-1
3' x 5'
264 gal
D
Water
P-2 / Manual Drum Pump
15 or 55 gal Drums
Sewer Inlet Draining to Lagoon

FIGURE 1. PROPOSED EQUIPMENT FOR WASTE BATTERY ACID OPTION

Waste Reduction Option
Recycle of Waste Battery Acid

1. Battery acid drained from batteries to be repaired or disposed of is collected in an existing trough and pump into holding tank TK-1. About 140 gallons per week of acid are accumulated. The block valves on the pH meter remain closed during this procedure. The specific gravity of the acid is checked and used to determine the waste acid strength. It is expected that the acid strength is below that needed for re-use in batteries.

2. The acid is recirculated through the filter and any increase in pressure on the discharge side of the centrifugal pump is noted. If the pressure approaches 10 psig, the circulation is stopped, the filter block valves closed, and the filter element cleaned. The material removed from the filter element may be hazardous. It is collected in plastic bags and sent to the Fort Riley DRMO (this waste should not be mixed with the neutralization sludge).

3. With the acid circulation continuing, 78% H_2SO_4 is slowly transferred by manual drum pump from the drain via a hose and the fill line into the tank. The quantity of acid to be added may be determined by reference to charts of specific gravity vs. acid strength, or by trial-and-error. In the latter case, the addition of 78% H_2SO_4 is stopped when the specific gravity of the mixture has reached the desired valve equivalent to battery acid strength (37-38% H_2SO_4).

4. The restrengthened battery acid is transferred from tank TK-1 to 15 gallons (or 55 gallons) storage drums prior to reuse in the battery repair shop.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 12

OPTION DESCRIPTION

EPA

Option Name: Recycle of Waste Battery Acid

Briefly describe the option Reuse waste battery acid by filtering and bringing the acid up to battery strength (37% H_2SO_4, sp. gr. 1.28) using 60° Baume acid (78% H_2SO_4). Other than particulates, the only known impurities in the waste acid are lead (normally present) and cadmium. These metals do not affect performance of battery acid (as far as is known) but field testing would be required to check this out.

Waste Stream(s) Affected: Waste battery acid

Input Material(s) Affected: Purchase of virgin battery acid

Product(s) Affected: N/A

Indicate Type:

☐ **Source Reduction**

- __ Equipment-Related Change
- __ Personnel/Procedure-Related Change
- __ Materials-Related Change

☒ **Recycling/Reuse**

- x Onsite
- __ Offsite
- x Material reused for original purpose
- __ Material used for a lower-quality purpose
- __ Material sold
- __ Material burned for heat recovery

Originally proposed by: Versar **Date:**

Reviewed by: **Date:**

Approved for study? __ **yes** __ **no, by:**

Reason for Acceptance or Rejection

Firm U.S. Army FORSCOM
Site Ft. Riley, Kansas
Date 9/30/89

Waste Minimization Assessment
Proc. Unit/Oper. ____________
Proj. No. ____________

Prepared By ____________
Checked By ____________
Sheet 1 of 1 Page 1 of 1

WORKSHEET 13

N/A

OPTIONS EVALUATION BY WEIGHTED SUM METHOD

EPA

Criteria	Weight (W)	Options Rating (R)									
		#1 Option		#2 Option		#3 Option		#4 Option		#5 Option	
		R	R x W	R	R x W	R	R x W	R	R x W	R	R x W
Reduction in waste's hazard											
Reduction of treatment/disposal costs											
Reduction of safety hazards											
Reduction of input material costs											
Extent of current use in industry											
Effect on product quality (no effect = 10)											
Low capital cost											
Low O & M cost											
Short implementation period											
Ease of implementation											
Final Evaluation	Sum of Weighted Ratings Σ (W x R)										
	Option Ranking										
Feasibility Analysis Scheduled for (Date)											

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 6 Page __ of __

WORKSHEET 14a

TECHNICAL FEASIBILITY

EPA

WM Option Description Recycle of waste battery acid

1. **Nature of WM Option**
   - ☒ **Equipment-Related**
   - ☒ **Personnel/Procedure-Related**
   - ☒ **Materials-Related**

2. **If the option appears technically feasible, state your rationale for this.** Waste acid appears clean and uncontaminated; dissolved metal impurities do not appear to affect performance; dilution is low and waste acid strengthening (refortification) does not require excessive amount of concentrated acid.

Is further analysis required? ☒ **Yes** ☐ **No.** **If yes, continue with this worksheet. If not, skip to worksheet 15.**

3. **Equipment - Related Option**

	YES	NO	
Equipment available commercially?	☒	☐	
Demonstrated commercially?	☒	☐	
In similar application?	☒	☐	
Successfully?	☒	☐	

Describe closest industrial analog Dilution of concentrated sulfuric acid with water to required acid strength for particular application.

Describe status of development Use of refortified acid by large lead-acid battery users is not known. Some field testing will be required at Ft. Riley to check battery performance following use of refortified acid.

Prospective Vendor	Working Installation(s)	Contact Person(s)	Date Contacted 1.
Stock items available commerciall	N/A		

Also attach filled out phone conversation notes, installation visit report, etc.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 2 of 6 Page __ of __

WORKSHEET 14b

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recycle of waste battery acid

3. Equipment-Related Option (continued)

Performance Information required (describe parameters): Test batteries that have been filled with refortified acid as to whether they hold an electrical charge properly; check performance of refortified acid-filled batteries in use in the field.

Scaleup Information required (describe): None

Testing Required: ☒ yes ☐ no

Scale: ☐ bench ☐ pilot ☒ Field testing

Test unit available? ☒ yes ☐ no Field testing

Test Parameters (list) Maintain voltage, amperage over expected life of battery.

Number of test runs:

Amount of material(s) required:

Testing to be conducted: ☒ in-plant ☐

Facility/Product Constraints:

Space Requirements 4 ft. x 6 ft.

Possible locations within facility Battery shop area

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 3 of 6 Page __ of __

WORKSHEET 14c

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recycle of waste battery acid

2. Equipment-Related Option (continued)

Utility Requirements:

Electric Power Volts (AC or DC) 115 V AC kW <1

Process Water Flow ____ Pressure ____

Quality (tap, demin, etc.) ____

Cooling Water Flow ____ Pressure ____

Temp. In ____ Temp. Out ____

Coolant/Heat Transfer Fluid ____

Temp. In ____ Temp. Out ____

Duty ____

Steam Pressure ____ Temp. ____

Duty ____ Flow ____

Fuel Type ____ Flow ____

Duty ____

Plant Air ____ Flow ____

Inert Gas ____ Flow ____

Estimated delivery time (after award of contract) items from stock

Estimated installation time two weeks

Installation dates Suited to EC services schedule

Estimated production downtime None

Will production be otherwise affected? Explain the effect and impact on production. N/A

Will product quality be affected? Explain the effect on quality. N/A

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 4 of 6 Page __ of __

WORKSHEET
14d

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recycle of waste battery acid

3. Equipment-Related Option (continued)

Will modifications to work flow or production procedures be required? Explain. None

Operator and maintenance training requirements

Number of people to be trained 1

☒ **Onsite**

☐ **Offsite**

Duration of training One week

Describe catalyst, chemicals, replacement parts, or other supplies required.

Item	Rate or Frequency of Replacement	Supplier, Address
60° Baume H_2SO_4	One week per month, replace recycled	Local supplier to be determined
(78% H_2SO_4)	acid with fresh acid diluted to 37%	
	H_2SO_4 strength onsite. Purchase	
	547 gallons/year of 60° Baume acid.	

Does the option meet government and company safety and health requirements?

☒ **Yes** ☐ **No** **Explain** Follow safety and health requirements already in place

How is service handled (maintenance and technical assistance)? Explain On-site testing equipment available.

What warranties are offered? N/A

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 5 of 6 Page of

WORKSHEET 14e

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recycle of waste battery acid

3. Equipment-Related Option (continued)

Describe any additional storage or material handling requirements. None

Describe any additional laboratory or analytical requirements. None

4. Personnel/Procedure-Related Changes

Affected Departments/Areas Battery repair shop

Training Requirements One operator - one week

Operating Instruction Changes. Describe responsible departments. Battery shop foreman will be responsible for new procedures. Supervision of new procedural steps by Ft. Riley DEH.

5. Materials-Related Changes (Note: If substantial changes in equipment are required, then handle the option as an equipment-related one.)

		Yes	No
Has the new material been demonstrated commercially?	N/A	☐	☐
In a similar application?	N/A	☐	☐
Successfully?	N/A	☐	☐

Describe closest application.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 6 of 6 Page of

WORKSHEET 14f

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recycle of waste battery acid

5. IV. **Materials-Related Changes (continued)**

Affected Departments/Areas Battery repair shop

Will production be affected? Explain the effect and impact on production.

No

Will product quality be affected? Explain the effect and the impact on product quality.

N/A

Will additional storage, handling or other ancillary equipment be required? Explain.

No

Describe any training or procedure changes that are required.

Initial training of shop personnel on proper acid dilution procedure

Decribe any material testing program that will be required.

Repaired battery testing to be carried out initially (voltage, amperage of charged batteries).

Firm U.S. Army FORSCOM
Site Ft. Riley, Kansas
Date 9/30/89

Waste Minimization Assessment
Proc. Unit/Oper. ____
Proj. No. ____

Prepared By ____
Checked By ____
Sheet 1 of 6 Page __ of __

WORKSHEET 15a

COST INFORMATION

EPA

WM Option Description Recycle of waste battery acid

CAPITAL COSTS - Include all costs as appropriate.

		TOTALS
☒ **Purchased Process Equipment**		
Price (fob factory)		
Taxes, freight, insurance		
Delivered equipment cost		
Price for Initial Spare Parts Inventory		3,900
☒ **Estimated Materials Cost**		
Piping		
Electrical		
Instruments		
Structural		
Insulation/Piping		1,600
☒ **Estimated Costs for Utility Connections and New Utility Systems**		
Electricity		
Steam		
Cooling Water		
Process Water		
Refrigeration		
Fuel (Gas or Oil)		
Plant Air		
Inert Gas		500
☐ **Estimated Costs for Additional Equipment**		
Storage & Material Handling		
Laboratory/Analytical		
Other		0
☐ **Site Preparation**		
(Demolition, site clearing, etc.)		0
☒ **Estimated Installation Costs**		
Vendor		
Contractor		
In-house Staff	4,000	4,000

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 2 of 6 Page __ of __

WORKSHEET 15b

COST INFORMATION
(continued)

EPA

CAPITAL COSTS (Cont.)		TOTALS
☒ Engineering and Procurement Costs (In house & outside)		
Planning		
Engineering	800	
Procurement	200	
Consultants		1,000
☒ Start-up Costs (contingency)		
Vendor		
Contractor		
In-house	3,000	3,000
☒ Training Costs	500	500
☒ Permitting Costs		
Fees	100	
In-house Staff Costs	200	300
☐ Initial Charge of Catalysts and Chemicals		
Item #1		
Item #2		0
☒ Working Capital [Raw Materials, Product, Inventory, Materials and Supplies (not elsewhere specified)].		
Item #1	50 percent NaOH	
Item #2	60° Baume H_2SO_4	
Item #3		
Item #4		400
☐ Estimated Salvage Value (if any)		0

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 3 of 6 Page __ of __

WORKSHEET
15c

COST INFORMATION

(continued)

EPA

CAPITAL COST SUMMARY

Cost Item	Cost, $
Purchased Process Equipment	3,900
Materials	1,600
Utility Connections	500
Additional Equipment	0
Site Preparation	0
Installation	4,000
Engineering and Procurement	1,000
Start-up Cost (Contingency)	3,000
Training Costs	500
Permitting Costs	300
Initial Charge of Catalysts and Chemicals	0
Fixed Capital Investment	14,800
Working Capital (3 months supply of H_2SO_4 and NaOH)	400
Total Capital Investment	15,200
Salvage Value	0

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 4 of 6 Page __ of __

WORKSHEET 15d

COST INFORMATION
(continued)

EPA

☐ **Estimated Decrease (or Increase) in Utilities**

Utility	Unit Cost $ per unit	Decrease (or Increase) in Quantity Unit per time	Total Decrease (or Increase) $ per time
Electricity			
Steam			
Cooling Process			
Process Water			
Refrigeration			
Fuel (Gas or Oil)			
Plant Air			
Inert Air			
Total			$500/year (increase)

INCREMENTAL OPERATING COSTS - Include all relevant operating savings. Estimate these costs on an incremental basis (i.e., as decreases or increases over existing costs).

☒ BASIS FOR COSTS Annual X Quarterly ____ Monthly ____ Daily ____ Other ____

☒ **Estimated Disposal Cost Saving**

	Recycle Waste Battery Acid
Decrease ~~in TSDF Fees~~ DRMO Disposal Cost	27,900
Decrease in State Fees and Taxes	-
Decrease in Transportation Costs	-
Decrease in Onsite Treatment and Handling	-
Decrease in Permitting, Reporting and Recordkeeping	-
Total Decrease in Disposal Costs	27,900

☐ **Estimated Decrease in Raw Materials Consumption**

Materials	Unit Cost $ per unit	Reduction in Quantity Units per time	Decrease in Cost $ per time
Battery acid (37% strength)	$1.90/gal.	6,150 gallon/year	$11,700/year

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 5 of 6 Page __ of __

WORKSHEET 15e

COST INFORMATION

(continued)

EPA

☒ **Estimated Decrease (or Increase) in Ancillary Catalysts and Chemicals**

Catalyst/Chemical	Unit Cost $ per unit	Decrease (or Increase) in Quantity Unit per time	Total Decrease (or Increase) $ per time***
NaOH (50% solution)*	$1.63/gal.	781 gal./year (increase)	$1,300 (increase)
H_2SO_4 (60° Be', 77%)**	$1.42/gal.	547 gal./year (increase)	$800 (increase)
Total			$2,100 (increase)

*For neutralization of 25% purge stream. **77% H_2SO_4 bought at commercial rates.

***Rounded to nearest $100/year.

☒ **Estimated Decrease (or Increase) in Operating Costs and Maintenance Labor Costs (Include cost of supervision, benefits and burden).**

($1,000/year) increase

☐ **Estimated Decrease (or Increase) in Operating and Maintenance Supplies and Costs.**

☐ **Estimated Decrease (or Increase) in Insurance and Liability Costs (explain).**

☐ **Estimated Decrease (or Increase) in Other Operating Costs (explain).**

INCREMENTAL REVENUES

☐ **Estimated Incremental Revenues from an Increase (or Decrease) in Production or Marketable By-products (explain).**

Battery Acid Recycle Option

Basis for Calculating Materials and Disposal Costs

1. Present Sulfuric Acid Cost

This cost is based on the replacement of H_2SO_4 sent to DRMO in 1988, specific gravity 1.24, 32.6 weight % H_2SO_4:

7,200 gal. x 1.24 x 8.344 lbs/gal. x 0.326 = 24,285 lbs H_2SO_4

Purchased at $1.90/gallon for 37 weight % H_2SO_4, specific gravity 1.28, the H_2SO_4 cost is:

$$\frac{\$1.90/\text{gal}}{8.334 \times 1.28 \times .37\ \text{lb/gal}} = \$0.481¢/\text{lb } H_2SO_4$$

The annual H_2SO_4 replacement cost thus is:

24,285 lbs H_2SO_4 x 0.4814 $/lb H_2SO_4 = $11,690.

2. Present Disposal Cost Via DRMO

The disposal charge being $3.87/gallon, the 1988 disposal cost was:

7,200 gallons x $3.87/gallon = $27,864.

3. Cost of Sulfuric Acid with Proposed Waste Minimization Option

Sulfuric acid, 60° Baume', specific gravity 1.705, 77.7 weight % H_2SO_4, is available from Ashland Chemical in Kansas City, KS, for about $1.42/gallon, or

$$\frac{\$1.42}{\text{gallon} \times 8.344 \times 1.705 \times .77\ \text{lbs/gallon}} = \$0.1285/\text{lb } H_2SO_4$$

This is about 27% of the sulfuric acid price currently paid: 100 x 0.1285/0.4814 = 26.7%.

We are assuming that 25% of the current H_2SO_4 throughput is purged and 75% is recycled for re-use. The quantity purged thus is:

24,284 x 0.25 = 6,071 lbs H_2SO_4

The replacement cost of this sulfuric acid at $0.1285/lb is:

6,071 x 0.1285 = $780.

4. Disposal Cost of Sulfuric Acid Purged from the System.

The sulfuric acid purged from the system must be neutralized and small quantities of heavy metal hydroxides (Pb, Cd) must be filtered out. The filtrate will be non-hazardous.

The cost of neutralization is determined as follows:

$$\frac{6{,}071 \text{ lbs } H_2SO_4}{49 \text{ lbs/lb - equivalent}} = 123.9 \text{ lb-equivalent}$$

$$\frac{1.63 \times (40 \text{ lbs/lb-equivalent})}{\text{gallon } 8.344 \times 1.525 \times 0.5 \text{ lbs/gallon}} = \$10.26\text{/lb-equivalent}$$

Thus the caustic cost is:

123.9 lb-equivalents x 10.26 $/lb-equivalent = $1,271.

The disposal cost of the filter cake from the filtration, expected to be negligible. If it is assumed that 200 mg/L of lead and cadmium hydroxide sludge are generated upon neutralization and filtration, the annual production of hazardous waste is:

7,200 gallons x 3.785 L/gallon x 200 mg/L x 10^{-6} kg/mg
= 5.45 kg = 12 lbs.

The annual disposal cost via DRMO should be less than $10.

Firm U.S. Army FORSCOM
Site Ft. Riley, Kansas
Date 9/30/89

Waste Minimization Assessment
Proc. Unit/Oper. ____
Proj. No. ____

Prepared By ____
Checked By ____
Sheet 6 of 6 Page __ of __

WORKSHEET
15 f

COST INFORMATION

(continued)

EPA

INCREMENTAL OPERATING COST AND REVENUE SUMMARY (ANNUAL BASIS)

Decreases in Operating Cost or Increases in Revenue are Positive.
Increases in Operating Cost or Decrease in Revenue are Negative.

	Waste Battery Acid Recycle
Operating Cost/Revenue Item	**$ per year**
Decrease in Disposal Cost	27,900
Decrease in Raw Materials Cost	11,700
Decrease (or Increase) in Utilities Cost	(500)
Decrease (or Increase) in Catalysts and Chemicals	(2,100)
Decrease (or Increase) in O & M Labor Costs	(1,000)
Decrease (or Increase) in O & M Supplies Costs	-
Decrease (or Increase) in Insurance/Liabilities Costs	-
Decrease (or Increase) in Other Operating Costs	-
Incremental Revenues from Increased (Decreased) Production	-
Incremental Revenues from Marketable By-products	-
Net Operating Cost Savings	36,000

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 16

PROFITABILITY WORKSHEET # 1
PAYBACK PERIOD

EPA

Waste Battery Acid Recycle

Total Capital Investment ($) (from Worksheet 15c) 15,200

Annual Net Operating Cost Savings ($ per year) (from Worksheet 15f) 36,000

Payback Period (in years) = $\frac{\text{Total Capital Investment}}{\text{Annual Net Operating Cost Savings}}$ = 0.42

APPENDIX B

WASTE MINIMIZATION ASSESSMENT WORKSHEETS BUILDING 8100 TORNADO WASHER WASTEWATER

Firm *U.S. Army FORSCOM*
Site *Fort Riley, Kansas*
Date *9/30/89*

Waste Minimization Assessment

Proj. No. ________

Prepared By ________
Checked By ________
Sheet *1* of *1* Page __ of __

WORKSHEET
2

PROGRAM ORGANIZATION

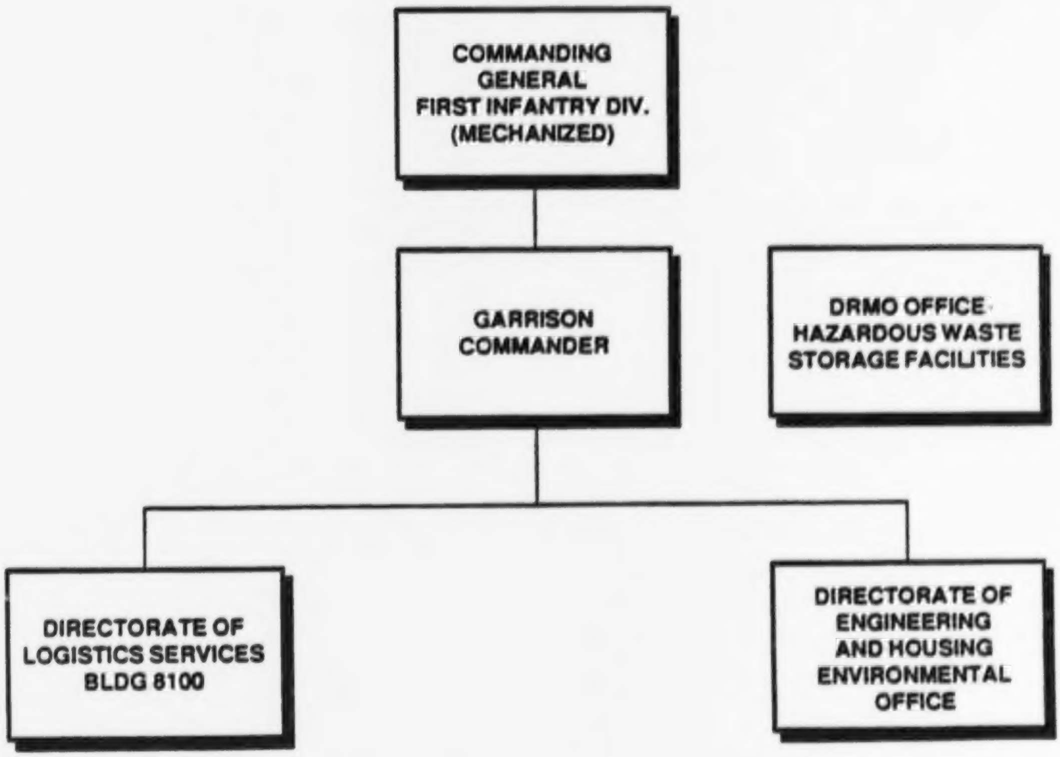
EPA

FUNCTION	NAME	LOCATION	TELEPHONE #
EPA Project Manager	Jim Bridges	EPA/ORD, Cincinnati, OH	513-569-7683
Site Coordinator	Charles Harris	Bldg. 133, Ft. Riley	913-239-3962
Assessment Team Leader	Marvin Drabkin	Versar Inc., Springfield, VA	703-750-3000

Organization Chart

(sketch)

FORT RILEY, KANSAS – PARTIAL ORGANIZATION CHART


COMMANDING GENERAL FIRST INFANTRY DIV. (MECHANIZED)
GARRISON COMMANDER
DRMO OFFICE HAZARDOUS WASTE STORAGE FACILITIES
DIRECTORATE OF LOGISTICS SERVICES BLDG 8100
DIRECTORATE OF ENGINEERING AND HOUSING ENVIRONMENTAL OFFICE

Firm Versar/U.S. Army Site Ft. Riley, Kansas Date 9/30/89	**Waste Minimization Assessment** Proj. No. ______	Prepared By ______ Checked By ______ Sheet 1 of 1 Page __ of __

WORKSHEET
3

ASSESSMENT TEAM MAKE-UP

EPA

Function/Department	Name	Location/ Telephone #	Manhours Required	Duties		
				Lead	Support	Review
Assessment Team						
Leader	Marvin Drabkin	(703) 750-3000				
Site Coordinator	Charles Harris	(913) 239-3962				
Operations	Milton McCabe	(913) 239-5235				
Engineering	Adolf Gessner	(703) 750-3000				
Maintenance						
Scheduling						
Materials Control						
Procurement						
Shipping/Receiving						
Facilities						
Quality Control						
Environmental	Max Diaz	(703) 750-3000				
Accounting						
Personnel						
R & D						
Legal						
Management						
Contractor/Consultant						
Safety						

Firm U.S. Army/FORSCOM **Site** Ft. Riley, Kansas **Date** 9/30/89	**Waste Minimization Assessment** **Proj. No.**	**Prepared By** **Checked By** **Sheet** 1 **of** 1 **Page** __ **of** __

WORKSHEET 4

SITE DESCRIPTION

EPA

Firm: U.S. Army FORSCOM

Plant: Ft. Riley, Custer Hill Area

Department: DOL/EC Services

Area: Automotive Subassembly Rebuild

Street Address: Bldg 8100

City: Ft. Riley

State/ZIP Code: Kansas/66442-5220

Telephone: (913) 239-5235

Major Products: Services: Repairing and rebuilding engines, transmissions, etc. from U.S. Army 1st Infantry Division (Mechanized) vehicles.

SIC Codes: 9711/7539

EPA Generator Number : KS6214020756

Major Unit or:

Product or:

Operations: Washing of combat vehicle parts, generating a wastewater characteristic in chromium (D007), and lead (D008). Washing operation operates one shift per day, 5 days per week, 14 employees.

Facilities/Equipment Age: Washing unit in operation about 5 years.

Firm U.S. Army/FORSCOM Site Ft. Riley, Kansas Date 9/30/89	**Waste Minimization Assessment** Proj. No. ______	Prepared By ______ Checked By ______ Sheet 1 of 1 Page __ of __

WORKSHEET
5

PERSONNEL

EPA

Attribute	**Overall**	**Department/Area**			
Total Staff					
Direct Supv. Staff					
Management					
Average Age, yrs.					
Annual Turnover Rate %					
Seniority, yrs.					
Yrs. of Formal Education					
Training, hrs./yr.					

Additional Remarks

N/A

Firm U.S. Army FORSCOM Site Ft. Riley, Kansas Date 9/30/89	Waste Minimization Assessment Proj. No. ______	Prepared By ______ Checked By ______ Sheet 1 of 1 Page __ of __

WORKSHEET 6

PROCESS INFORMATION

EPA

Process Unit/Operation: Combat vehicle parts washer

Operation Type:
☐ Continuous
☐ Discrete
☒ Batch or Semi-Batch
☐ Other ______

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N	N		N		
Material/Energy Balance	N	N		N		
Design						
Operating						
Flow/Amount Measurements						
Stream						
Tornado washer wastewater	Y	Y		Y		
Analyses/Assays						
Stream						
Tornado washer wastewater	Y	Y		Y		
Process Description	y	y		y		
Operating Manuals						
Equipment List						
Equipment Specifications	y	y		y		
Piping & Instrument Diagrams	N	N		N		
Plot and Elevation Plan(s)	N	N		N		
Work Flow Diagrams	N	N		N		
Hazardous Waste Manifests	N	N		N		
Emission Inventories	N	N		N		
Annual/Biennial Reports	N	N		N		
Environmental Audit Reports	N	N		N		
Permit/Permit Applications	N	N		N		
Batch Sheet(s)	N	N		N		
Materials Application Diagrams	N	N		N		
Product Composition Sheets	N	N		N		
Material Safety Data Sheets	Y	Y		Y		
Inventory Records	N	N		N		
Operator Logs	N	N		N		
Production Schedules	N	N		N		

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By ____
Site Ft. Riley, Kansas		Checked By ____
Date 9/30/89	Proj. No. ____	Sheet 1 of 1 Page __ of __

WORKSHEET
7

INPUT MATERIALS SUMMARY

EPA

Attribute	Description		
	Stream No. 2	Stream No.___	Stream No.___
Name/ID	N/A		
Source/Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, $ per ______			
Overall Annual Cost			
Delivery Mode[1]			
Shipping Container Size & Type[2]			
Storage Mode[3]			
Transfer Mode[4]			
Empty Container Disposal/Management[5]			
Shelf Life			
Supplier Would			
- accept expired material (Y/N)			
- accept shipping containers (Y/N)			
- revise expiration date (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

[1] e.g., pipeline, tank car, 100 bbl. tank truck, truck, etc.

[2] e.g., 55 gal. drum, 100 lb. paper bag, tank, etc.

[3] e.g., outdoor, warehouse, underground, aboveground, etc.

[4] e.g., pump, forklift, pneumatic transport, conveyor, etc.

[5] e.g., crush and landfill, clean and recycle, return to supplier, etc.

Firm U.S. Army FORSCOM Site Ft. Riley, Kansas Date 9/30/89	**Waste Minimization Assessment** Proj. No. ______	Prepared By ______ Checked By ______ Sheet 1 of 1 Page __ of __

WORKSHEET 8

PRODUCTS SUMMARY

EPA

Attribute	Description		
	Stream No. 2	Stream No.____	Stream No.____
Name/ID	N/A		
Component/Attribute of Concern			
Annual Production Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $ ______			
Shipping Mode			
Shipping Container Size & Type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
- relax specification (Y/N)			
- accept larger containers (Y/N)			

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas		Checked By
Date 9/30/89	Proj. No.	Sheet 2 of 4 Page __ of __

WORKSHEET 9a

INDIVIDUAL WASTE STREAM CHARACTERIZATION

EPA

1. **Waste Stream Name/ID:** Waste wash water **Stream Number** 2
   Process Unit/Operation Combat vehicle parts washer

2. **Waste Characteristics**

   ☐ gas ☒ liquid ☐ solid ☐ mixed phase

   Density, lb/cuft 70
   Viscosity/Consistency
   pH abt. 10 ,Flash Point N/A ; % Water 98%+

3. **Waste Leaves Process as:**
   ☐ air emission ☒ waste water ☐ solid waste ☐ hazardous waste

4. **Occurrence**
   ☐ continuous
   ☒ discrete
   discharge triggered by ☐ chemical analysis
   ☐ other (describe) arbritary schedule
   Type: ☒ periodic length of period: 5 days
   ☐ sporadic (irregular occurrence)
   ☐ non-recurrent

5. **Generation Rate**
   Annual 242,000 lbs per year
   Maximum lbs per
   Average lbs per
   Frequency 1 batches per week
   Batch Size 580 gallons average range

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 2 of 4 Page __ of __

WORKSHEET 9b

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

6. Waste Origins/Sources

Fill out this worksheet to identify the origin of the waste. If the waste is a mixture of waste streams, fill out a sheet for each of the individual waste streams.

Is the waste mixed with other wastes? ☒ Yes ☐ No.

Check — Describe

☐ Formulation/Removal of Undesirable Compound

☐ Unconverted Hazardous Raw Materials or Additive

☐ Accumulation of Inert Impurity

☐ Depletion of Key Component(s)

☒ Equipment Cleaning - removal of oil, grease, dirt from metal parts.

☐ Obsolete Stock

☐ Spoiled Batch/Production Run

☐ Spill/Leak Cleanup

☐ Evaporative Loss

☐ Breathing/Venting Losses

☐ Other

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 3 of 4 Page __ of __

WORKSHEET
9c

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

Waste Stream Tornado washer wastewater

7. **Management Method**

Leaves site in
☐ bulk
☐ roll off bins
☐ 55 gal drums
☒ other (describe) Presently goes to onsite non-hazardous wastewater system; when waste is reclassified RCRA hazardous, will have to be sent offsite-probably in 55 gallon

Disposal Frequency 580 gallons per week to onsite impoundment system equivalent to about 11-55 gallon drums per week when sent offsite.

Applicable Regulations[1] RCRA (when reclassified)

Regulatory Classification[2] D007, D008 (when reclassified)

Managed
☒ onsite ☐ offsite
☐ commercial TSDF
☐ own TSDF
☐ other (describe)

Recycling
☐ direct use/re-use
☐ combusted for energy content
☐ redistilled
☐ other (describe)

reclaimed material returned to site?
☐ Yes ☐ No ☐ used by others
residue yield
residue disposal/repository

Note[1] list federal, state & local regulations, (e.g., RCRA, TSCA, etc.)

Note[2] list pertinent regulatory classification (e.g., RCRA - Listed K011 waste, etc.)

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 4 of 4 Page __ of __

WORKSHEET
9d

INDIVIDUAL WASTE STREAM CHARACTERIZATION

(continued)

EPA

Waste Stream Tornado washer wastewater

7. **Management Method (continued)**

Treatment

☐ biological

☐ oxidation/reduction

☐ incineration

☐ pH adjustment

☐ precipitation

☐ solidification

☐ other (describe) Decanting of tramp oil followed by draining to onsite nonhazardous surface impoundment system.

residue disposal/repository Onsite nonhazardous evaporative pond system

Final Disposition

☐ landfill

☐ pond

☐ lagoon

☐ deep well

☐ ocean

☐ other (describe)

Costs as of ________ (quarter and year) N/A

Cost Element:	Unit Price $ per ____	Reference/Source:
Onsite Storage & Handling		
Pretreatment		
Container		
Transportation Fee		
Disposal Fee		
Local Taxes		
State Tax		
Federal Tax		
Total Disposal Cost		

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By ______
Site Ft. Riley, Kansas	Proc. Unit/Oper. ______	Checked By ______
Date 9/30/89	Proj. No. ______	Sheet 1 of 1 Page __ of __

WORKSHEET 10

WASTE STREAM SUMMARY

EPA

Attribute	Description		
	Stream No. 2	Stream No.___	Stream No.___
Waste ID/Name:	Waste wash water		
Source/Origin	Tornado parts washer		
Component/or Property of Concern	Pb, pH		
Annual Generation Rate (units ________)			
Overall	29,000 gallon/year		
Component(s) of Concern	Pb, Cr		
Cost of Disposal	0		
Unit Cost ($ per: ________)			
Overall (per year)			
Method of Management[1]	Disposal to onsite nonhazardous waste surface impoundment		

Priority Rating Criteria[2] N/A	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(R \times W)$		$\Sigma(R \times W)$		$\Sigma(R \times W)$	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, onsite recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.

2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET 11

OPTION GENERATION

EPA

Meeting format (e.g., brainstorming, nominal group technique) Brainstorming

Meeting Coordinator M. Drabkin

Meeting Participants M. Drabkin, A. Gessner, M. Diaz

List Suggested Options	Rationale/Remarks on Option
Clean up washwater once per week (at the end of work week) by decanting from oils and sludge, de-emulsifying oils in external tank, adding appropriate amount of alkaline detergent makeup as necessary and recycle to Tornado washer. When water detergency deteriorates (to be determined by experience), neutralize washer water (to pH 9-10) in external tank, using waste battery acid, settle and filter small amount of lead and other heavy metal hydroxides, and sewer neutralized wastewater. Dispose of heavy metal sludge intermittently as required (D007, D008 sludge).	Tornado washer manufacturer states that this is feasible option as long as emulsified oils in water are removed periodically - detergency of alkaline wash solution should continue indefinitely using this method. Newer washer designs have higher velocity hot water jets designed to breakup emulsified oils and thus maintain solution detergency. Periodic neutralization and heavy metals precipitation of purged stream (at appropriate alkaline pH) is routine operation in industry.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By ____
Site Ft. Riley, Kansas	Proc. Unit/Oper. ____	Checked By ____
Date 9/30/89	Proj. No. ____	Sheet 1 of 1 Page ___ of ___

WORKSHEET 12

OPTION DESCRIPTION

EPA

Option Name: Recirculate automotive parts washer wastewater to Tornado washer unit, following cleanup

Briefly describe the option See Worksheet 11

Waste Stream(s) Affected: Waste wash water from Tornado washer (to be designated as D007, D008).

Input Material(s) Affected: None

Product(s) Affected: None

Indicate Type:

☐ **Source Reduction**
- ___ **Equipment-Related Change**
- ___ **Personnel/Procedure-Related Change**
- ___ **Materials-Related Change**

☐ **Recycling/Reuse**

x	**Onsite**	x	**Material reused for original purpose**
___	**Offsite**	___	**Material used for a lower-quality purpose**
		___	**Material sold**
		___	**Material burned for heat recovery**

Originally proposed by: Versar **Date:** ____

Reviewed by: ____ **Date:** ____

Approved for study? ____ **yes** ____ **no, by:** ____

Reason for Acceptance or Rejection ____

Firm U.S. Army FORSCOM
Site Ft. Riley, Kansas
Date 9/30/89

Waste Minimization Assessment
Proc. Unit/Oper. ____
Proj. No. ____

Prepared By ____
Checked By ____
Sheet 1 of 1 Page 1 of 1

WORKSHEET 13

N/A

OPTIONS EVALUATION BY WEIGHTED SUM METHOD

EPA

Criteria	Weight (W)	Options Rating (R)									
		#1 Option		#2 Option		#3 Option		#4 Option		#5 Option	
		R	R x W	R	R x W	R	R x W	R	R x W	R	R x W
Reduction in waste's hazard											
Reduction of treatment/disposal costs											
Reduction of safety hazards											
Reduction of input material costs											
Extent of current use in industry											
Effect on product quality (no effect = 10)											
Low capital cost											
Low O & M cost											
Short implementation period											
Ease of implementation											
Final Evaluation	Sum of Weighted Ratings Σ (W x R)										
	Option Ranking										
Feasibility Analysis Scheduled for (Date)											

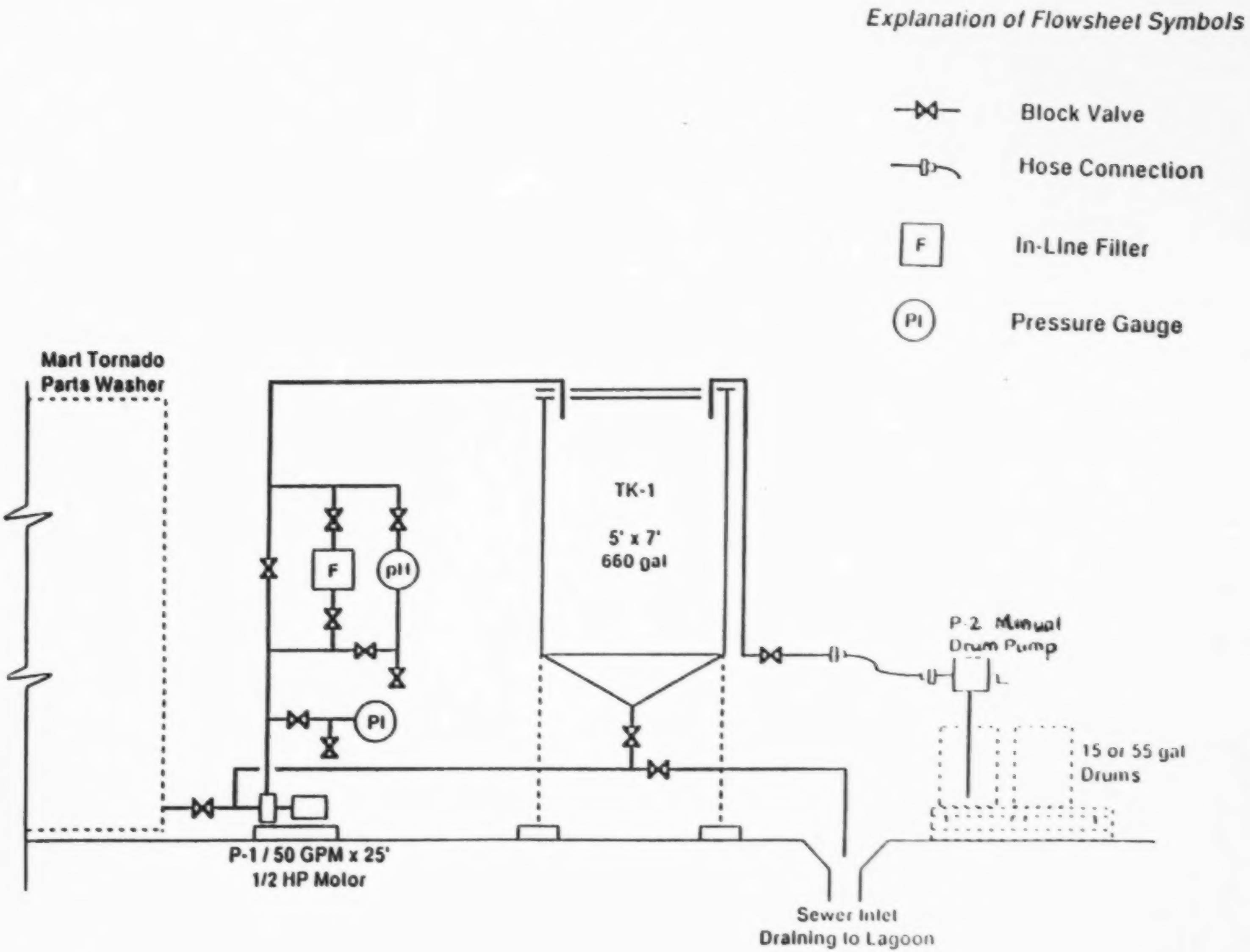

Explanation of Flowsheet Symbols
Block Valve
Hose Connection
F
In-Line Filter
PI
Pressure Gauge
Mart Tornado
Parts Washer
F
pH
PI
P-1 / 50 GPM x 25'
1/2 HP Motor
TK-1
5' x 7'
660 gal
P-2 Manual
Drum Pump
15 or 55 gal
Drums
Sewer Inlet
Draining to Lagoon

FIGURE 2. *PROPOSED EQUIPMENT FOR TORNADO PARTS WASHER WASTEWATER OPTION*

Automotive Parts Washer Wastewater Cleanup and Recycle Option

Re-Use of Tornado Parts Washer Wash Solution

1. At the end of each weekly operation, the wash solution is allowed to drain to the sump of the Mart Tornado parts washer. The solution (550-580 gallons) is pumped through the filter into the tank TK-1.

2. If the pump discharge pressure approaches 10 psig, pumping is stopped and the filter element is removed. Dirt accumulated on the filter element is removed and put in a plastic bag, and the filter element is put back into the filter cartridge. This procedure is repeated if necessary until all sump contents have been transferred to the tank.

3. Once the filtered wash water is in tank TK-1, a de-emulsifier is added and the contents of the tank recirculated using the circulation pump. After a sufficient mixing period, the separated oils are allowed to float to the top of the water in the tank and skimmed off by hand.

4. Tar and grease accumulations in the empty Tornado parts washer are mechanically removed and put in plastic bags. The contents of the tank now is drained into the sump of the parts washer and re-used.

5. Throughout this procedure, the pH meter remains blocked in.

6. If detergency of re-used solution is deemed unsatisfactory, additional solid detergent is thrown into the parts washer sump prior to reuse of the washer solution.

7. An arbitrary washer solution replacement schedule (pending testing of the above procedure) is proposed wherein every 4th week, the 580 gallon batch of washer solution is replaced with fresh solution. The discarded alkaline solution is neutralized with waste battery acid in tank TK-1, as described in the following steps:

a. A few drums of waste battery acid are moved to the vicinity of the tank from the battery repair shop.

b. The wash solution is circulated by the centrifugal pump with the bypass valve open. The block valves on the pH meter are cracked open and a flow through the meter is established. The pH is normally about 10 but could reach as high as 12.

c. Waste battery acid is next pumped into the tank by drum pump via a hose connected to the fill line. Acid addition is continued until the pH meter indicates a pH of 9-10. Floc is added to the tank (the type of floc and its dosage to be determined).

d. The filter block valves are opened and the bypass valve is closed. The pump discharge pressure is monitored. When it approaches 10 psig, the bypass valve is opened, the filter blocked in and the filter element removed. Sludge is removed from the filter element and put in plastic bags. The filter element is then put back into the filter cartridge and filtration is continued. When filter element is no longer cleanable, it is disposed of as hazardous wastes (D007, D008) and replaced with a fresh cartridge.

e. When there is no further pressure buildup, the tank contents are drained to the sewer.

f. All sludge collected from the filter element is sent to the Fort Riley DRMO for disposal as hazardous wastes. Accumulation of sludge (including added flocculant and filter acid) is not expected to exceed 1-2 pounds per batch of spent washwater treated.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 6 Page __ of __

WORKSHEET 14a

TECHNICAL FEASIBILITY

EPA

WM Option Description Recirculate Tornado washer wastewater following cleanup

1. **Nature of WM Option**
   - ☒ **Equipment-Related**
   - ☒ **Personnel/Procedure-Related**
   - ☒ **Materials-Related**
2. **If the option appears technically feasible, state your rationale for this.** De-emulsifying waste water for oil removal is proven commercial operation; Tornado washer manufacturer indicates that properly de-emulsified washer water will enable its reuse in their equipment indefinitely.

Is further analysis required? ☒ **Yes** ☐ **No.** **If yes, continue with this worksheet. If not, skip to worksheet 15.**

3. **Equipment - Related Option**

	YES	NO	
Equipment available commercially?	☒	☐	
Demonstrated commercially?	☒	☐	
In similar application?	☒	☐	
Successfully?	☒	☐	

Describe closest industrial analog De-emulsification of oils in washwater is common industry practice.

Describe status of development Proven technology

Prospective Vendor	Working Installation(s)	Contact Person(s)	Date Contacted 1.
Equipment from stock			

1. **Also attach filled out phone conversation notes, installation visit report, etc.**

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By ____
Site Ft. Riley, Kansas	Proc. Unit/Oper. ____	Checked By ____
Date 9/30/89	Proj. No. ____	Sheet 2 of 6 Page __ of __

WORKSHEET 14b

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recirculate Tornado washer wastewater following cleanup

3. Equipment-Related Option (continued)

Performance information required (describe parameters): Lab-scale de-emulsification testing

Scaleup information required (describe): None

Testing Required: ☒ yes ☐ no

Scale: ☒ bench ☐ pilot ☐ ____

Test unit available? ☒ yes ☐ no

Test Parameters (list)

Amount of de-emulsifier to be added

Mixing time

Separation time

Number of test runs: 6

Amount of material(s) required: 0.5 gallon of Tornado washer spent washwater

Testing to be conducted:

☐ In-plant

☒ In Versar laboratory

Facility/Product Constraints:

Space Requirements 6 ft. x 10 ft.

Possible locations within facility Adjacent to Tornado parts washer

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By ______
Site Ft. Riley, Kansas	Proc. Unit/Oper. ______	Checked By ______
Date 9/30/89	Proj. No. ______	Sheet 3 of 6 Page __ of __

WORKSHEET
14c

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recirculating Tornado washer wastewater following cleanup

2. Equipment-Related Option (continued)

Utility Requirements:

Electric Power Volts (AC or DC) 115 (AC) kW <1

Process Water Flow ______ Pressure ______

Quality (tap, demin, etc.) ______

Cooling Water Flow ______ Pressure ______

Temp. In ______ Temp. Out ______

Coolant/Heat Transfer Fluid ______

Temp. In ______ Temp. Out ______

Duty ______

Steam Pressure ______ Temp. ______

Duty ______ Flow ______

Fuel Type ______ Flow ______

Duty ______

Plant Air ______ Flow ______

Inert Gas ______ Flow ______

Estimated delivery time (after award of contract) Items from stock

Estimated installation time Two weeks

Installation dates Suited to EC services schedule

Estimated production downtime None

Will production be otherwise affected? Explain the effect and impact on production. N/A

Will product quality be affected? Explain the effect on quality. No.

Firm U.S. Army FORSCOM Site Ft. Riley, Kansas Date 9/30/89	**Waste Minimization Assessment** Proc. Unit/Oper. ____ Proj. No. ____	Prepared By ____ Checked By ____ Sheet 4 of 6 Page __ of __

WORKSHEET 14d

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recirculating Tornado washer wastewater, following cleanup

3. Equipment-Related Option (continued)

Will modifications to work flow or production procedures be required? Explain. No

Operator and maintenance training requirements

Number of people to be trained 2-3

☒ Onsite

☐ Offsite

Duration of training 1 day

Describe catalyst, chemicals, replacement parts, or other supplies required.

Item	Rate or Frequency of Replacement	Supplier, Address
Filter aid	To be determined	Various
Filter cartridge	To be determined	Various
Deemulsifier	To be determined	Various

Does the option meet government and company safety and health requirements?

☒ Yes ☐ No Explain New operation will follow existing plant health and safety requirements

How is service handled (maintenance and technical assistance)? Explain Routine maintenance required; technical assistance to be provided by DEH personnel.

What warranties are offered? N/A

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 5 of 6 Page __ of __

WORKSHEET 14e

TECHNICAL FEASIBILITY

(continued)

EPA

WM Option Description Recirculating Tornado washer wastewater following cleanup

3. Equipment-Related Option (continued)

Describe any additional storage or material handling requirements. Storage of filter aid, filter cartridges, and de-emulsifier. Minimal area requirements.

Describe any additional laboratory or analytical requirements. None

4. Personnel/Procedure-Related Changes

Affected Departments/Areas Bldg 8100 Automotive subassembly rebuild area, tornado washer operation.

Training Requirements 2-3 operators, 1 day

Operating Instruction Changes. Describe responsible departments. EC Services operating procedures change. Designated personnel to learn new washwater cleanup procedure to be conducted during off-hours (evenings or weekend time periods) as appropriate.

5. Materials-Related Changes (Note: If substantial changes in equipment are required, then handle the option as an equipment-related one.) N/A

	Yes	No
Has the new material been demonstrated commercially?	☐	☐
In a similar application?	☐	☐
Successfully?	☐	☐

Describe closest application.

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/88	Proj. No.	Sheet 6 of 6 Page __ of __

WORKSHEET 14f

TECHNICAL FEASIBILITY

(continued)

WM Option Description Recirculating Tornado washer wastewater, following cleanup

5. 4/ **Materials-Related Changes (continued)**

Affected Departments/Areas N/A

Will production be affected? Explain the effect and impact on production.

No

Will product quality be affected? Explain the effect and the impact on product quality.

No

Will additional storage, handling or other ancillary equipment be required? Explain.

No

Describe any training or procedure changes that are required.

N/A

Decribe any material testing program that will be required.

N/A

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Date 9/30/89	Proj. No.	Sheet 1 of 6 Page __ of __

WORKSHEET 15a

COST INFORMATION

EPA

WM Option Description Recirculate Tornado washer wastewater following cleanup

CAPITAL COSTS - include all costs as appropriate.		TOTALS
☒ **Purchased Process Equipment**		
Price (fob factory)		
Taxes, freight, insurance		
Delivered equipment cost		
Price for initial Spare Parts inventory		5,300
☒ **Estimated Materials Cost**		
Piping		
Electrical		
Instruments		
Structural		
Insulation/Piping		2,000
☒ **Estimated Costs for Utility Connections and New Utility Systems**		
Electricity		
Steam		
Cooling Water		
Process Water		
Refrigeration		
Fuel (Gas or Oil)		
Plant Air		
Inert Gas		500
☐ **Estimated Costs for Additional Equipment**		
Storage & Material Handling		
Laboratory/Analytical		
Other		0
☐ **Site Preparation**		0
(Demolition, site clearing, etc.)		
☒ **Estimated Installation Costs**		
Vendor		
Contractor		
In-house Staff	5,000	5,000

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Date 9/30/89	Proj. No.	Sheet 2 of 6 Page __ of __

WORKSHEET 15b

COST INFORMATION

(continued)

EPA

CAPITAL COSTS (Cont.)

		TOTALS
☐ **Engineering and Procurement Costs (in-house & outside)**		
Planning		
Engineering		
Procurement		
Consultants		2,000
☒ **Start-up Costs**		
Vendor		
Contractor		
In-house	(contingency)	4,000
☒ **Training Costs**		500
☐ **Permitting Costs**		
Fees		
In-house Staff Costs		0
☐ **Initial Charge of Catalysts and Chemicals**		
	Item #1	
	Item #2	0
☒ **Working Capital** [Raw Materials, Product, Inventory, Materials and Supplies (not elsewhere specified)].		
	Item #1	
	Item #2	
	Item #3	
	Item #4	1,400
☐ **Estimated Salvage Value (if any)**		0

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Date 9/30/89	Proj. No.	Sheet 3 of 6 Page __ of __

WORKSHEET 15c

COST INFORMATION

(continued)

EPA

CAPITAL COST SUMMARY

Cost Item	Cost
Purchased Process Equipment	5,300
Materials	2,000
Utility Connections	500
Additional Equipment	0
Site Preparation	0
Installation	5,000
Engineering and Procurement	2,000
~~Start-up Cost~~ Contingency	4,000
Training Costs	500
Permitting Costs	0
Initial Charge of Catalysts and Chemicals	0
Fixed Capital Investment	19,300
Working Capital (3 months supply of filter aid, filter cartridges, and de-emulsifer	500
Total Capital Investment	19,800
Salvage Value	0

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Date 9/30/89	Proj. No.	Sheet 4 of 6 Page __ of __

WORKSHEET
15d

COST INFORMATION
(continued)

EPA

☒ Estimated Decrease (or Increase) in Utilities

Utility	Unit Cost $ per unit	Decrease (or Increase) in Quantity Unit per time	Total Decrease (or Increase) $ per time
Electricity			
Steam			
Cooling Process			
Process Water			
Refrigeration			
Fuel (Gas or Oil)			
Plant Air			
Inert Air			
			$500/year (increase)

INCREMENTAL OPERATING COSTS - Include all relevant operating savings. Estimate these costs on an incremental basis (i.e., as decreases or increases over existing costs).

☒ BASIS FOR COSTS Annual X Quarterly ______ Monthly ______ Daily ______ Other ______

☐ Estimated Disposal Cost Saving

	Option	Tornado Washwater Recirculation
Decrease in DRMO disposal cost		112,000
Decrease in State Fees and Taxes		-
Decrease in Transportation Costs		-
Decrease in Onsite Treatment and Handling		-
Decrease in Permitting, Reporting and Recordkeeping		
Total Decrease in Disposal Costs		$112,000

*Assuming a $3.87/gallon disposal cost to DRMO when this wastewater is reclassified RCRA hazardous.

☒ Estimated Decrease in Raw Materials Consumption**

Materials	Unit Cost $ per unit	Reduction in Quantity Units per time	Decrease in Cost $ per time
Alkaline washing detergent	$1.86/lb	200 lb.	$400

**Recycled tornado washwater option.

Parts-Washing Detergent Solution Recycle

Basis for Calculating Disposal Costs

580 gallons of detergent solution are drained weekly from the MART parts cleaner in Bldg 8100. Assuming 50 weeks of operation per year, the quantity of waste generated is:

50 x 580 = 29,000 gallon/year.

This waste has been reported to contain traces of chromium and lead, potentially making the waste RCRA hazardous waste D007 and D008. If this waste were disposed of via DRMO at $3.87/gallon, the annual disposal cost would be:

29,000 x 3.87 = 112,230.

In the proposed waste minimizations option, 75% of the detergent solution is recycled for re-use and 25% is disposed of. If the pH of the waste solution should be as high as 12, disposal involves addition of acid to drop the pH from about 12 ($OH^- \approx 0.01$ gm-equivalents/L) to 9-10. The quantity of acid needed to accomplish this is approximately:

29,000 gallons x 0.25 x 3.785 L/gal x 0.01 gm-equivalent/L = 274 gm-equivalents.

274 gm-equivalents x (49 gm H_2SO_4/gm-equivalent)
x (lb/453.6 gms)
= 29.6 lbs H_2SO_4

It is apparent that a small fraction of the waste battery acid available from the battery repair shop is sufficient to make this pH adjustment. The cost of materials for this pH adjustment therefore is nil.

The annual amount of hazardous waste collected by the in-line filter proposed in this waste minimization option is estimated as follows:

29,000 gallons x 0.25 x 3.785 x (100 mg/L toxic metals, assumed) x 10^{-6} kg/mg = 2.74 kg = 6 lbs.

The annual disposal cost of this material via DRMO should be less than $5.

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Date 9/30/89	Proj. No.	Sheet 5 of 6 Page __ of __

WORKSHEET
15e

COST INFORMATION

(continued)

EPA

☒ **Estimated Decrease (or Increase) in Ancillary Catalysts and Chemicals**

Catalyst/Chemical	Unit Cost $ per unit	Decrease (or Increase) in Quantity Unit per time	Total Decrease (or Increase) $ per time
Filter Aid			
Filter Cartridges			($2,000/year)
De-emulsifier			

☐ **Estimated Decrease (or Increase) in Operating Costs and Maintenance Labor Costs (Include cost of supervision, benefits and burden).**

($2,000/year) increase

☐ **Estimated Decrease (or Increase) in Operating and Maintenance Supplies and Costs.**

N/A

☐ **Estimated Decrease (or Increase) in Insurance and Liability Costs (explain).**

☐ **Estimated Decrease (or Increase) in Other Operating Costs (explain).**

INCREMENTAL REVENUES

☐ **Estimated Incremental Revenues from an Increase (or Decrease) in Production or Marketable By-products (explain).**

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Date 9/30/89	Proj. No. ____	Sheet 6 of 6 Page __ of __

WORKSHEET 15 f

COST INFORMATION

(continued)

EPA

INCREMENTAL OPERATING COST AND REVENUE SUMMARY (ANNUAL BASIS)

Decreases in Operating Cost or Increases in Revenue are Positive.
Increases in Operating Cost or Decrease in Revenue are Negative.

Tornado Washer Wastewater Recirculation

Operating Cost/Revenue Item	$ per year
Decrease in Disposal Cost	112,000
Decrease in Raw Materials Cost	400
Decrease (or Increase) in Utilities Cost	(500)
Decrease (or Increase) in Catalysts and Chemicals	(2,000)
Decrease (or Increase) in O & M Labor Costs	(2,000)
Decrease (or Increase) in O & M Supplies Costs	-
Decrease (or Increase) in Insurance/Liabilities Costs	-
Decrease (or Increase) in Other Operating Costs	-
Incremental Revenues from Increased (Decreased) Production	-
Incremental Revenues from Marketable By-products	-
Net Operating Cost Savings	107,100

Firm U.S. Army FORSCOM	**Waste Minimization Assessment**	Prepared By
Site Ft. Riley, Kansas	Proc. Unit/Oper.	Checked By
Date 9/30/89	Proj. No.	Sheet 1 of 1 Page __ of __

WORKSHEET
16

PROFITABILITY WORKSHEET # 1
PAYBACK PERIOD

EPA

Tornado Washer Wastewater Recirculation Option

Total Capital Investment ($) (from Worksheet 15c) 19,800

Annual Net Operating Cost Savings ($ per year) (from Worksheet 15f) 107,100

$$\textbf{Payback Period (in years)} = \frac{\textbf{Total Capital Investment}}{\textbf{Annual Net Operating Cost Savings}} = 0.18$$

APPENDIX C

MATERIALS SAFETY DATA SHEETS
FEDERAL SPECIFICATION D-S-801C

RECEIVED AUG 2 3 1989

Material Safety Data Sheet

Comply with 29 CFR 1910.1200,
OSHA's Hazard Communication Standard

Super Z Ultrasonic Stripper 33-00

USED TO MAKE RADIATOR CAUSTIC CLEANER SOLUTION

Section I:

Johnson Manufacturing Company	Emergency Telephone (319)-289-5123
114 Lost Grove Road	CHEMTREC 1-(800)-424-9300
Princeton IA 52768	Revised 5/23/89

Section II: Hazardous Ingredients/Identity information

Hazardous Component	OSHA TWA	ACGIH TWA	Other limits
sodium hydroxide 1310-73-2	2mg/M3 C	2mg/m3 C	NE

C = Ceiling concentration

Only those ingredients listed in this section have been determinded to be hazardous as defined in 29CFR 1910.1200. An ingredient marked with an asterisk(*) is also listed in 29CFR 1910.1200(D) #4 as a known or suspected cancer hazard.

+ denotes a chemical regulated as toxic by the Environmental Protection Agency (EPA) as outlined in 40CFR Part 372 (section 313)

Section III: Physical/Chemical Characteristics

Boiling Point: 2530 F	Specific Gravity: NE
Vapor Pressure (mm Hg): NE	Melting Point: NE
Vapor Density: NE	Evaporation Rate
Solubility in water: 100%	(butyl acetate=1): <1

Appearance and odor: white solid - odorless

Section IV: Fire and Explosion Hazard Data

Flash Point: nonflammable Flammable limits lel NE uel NE
Extinguishing media: all
Special fire fighting procedures: use self sustaining respiratory suit
Unusual Fire and Explosion Hazards: NONE

Section V: Reactivity Data

Stability : STABLE Conditions to avoid : none
Incompatibility (materials to avoid): strong acids, water, aluminum, tin, zinc, and alloys containing these metals; also leather and wool
Hazardous Decomposition or Byproducts: none
Hazardous Polymerization: WILL NOT OCCUR Conditions to avoid: none

Section VI: Health Hazard Data

Routes of entry: Inhalation yes Skin no Ingestion yes

Health Hazards (acute and chronic)

Irritation may result from contact. Tissue damage may result from prolonged or repeated contact. Health studies have shown that potential health risks may vary by indiv

Always minimize exposure as a precaution.

Carcinogenicity: not determined NTP? no IARC Monographs? no OSHA Regulated? no

Signs and symptoms of exposure: Inhalation-headache, dizziness, difficulty breathing. Ingestion-nausea, vomiting, cramps. Skin-redness, burning, rash, dryness. Eye-redness, burning, tearing, blurred vision.

Medical Conditions Aggravated by exposure: skin and respiratory conditions

Emergency first aid procedures:

Skin: Flush with water immediately - Seek medical attention

Eyes: Flush with water for 15 minutes - Seek medical attention

Ingestion: Drink large amounts of water - seek medical attention. Never give liquids to an unconscious person. DO NOT INDUCE VOMITING.

Inhalation: Remove to fresh air. Support respiration if required - Seek medical attention.

Section VII: Precautions for Safe Handling and Use

Steps to be taken if material is released or spilled: Flush into a chemical sewer or soak up with a suitable absorbant.

Waste Disposal Method: dispose of in accordance with all local state and federal regulatio

Other Precautions: Avoid contact. Store in a cool dry place.

Section VIII: Control Measures

Respiratory Protection (type): Dust mask required for fumes over TLV.

Ventilation Local Exhaust preferred Special NE

Mechanical OK Other NE

Protective Gloves: plastic or rubber Eye Protection: Goggles or face shield

Other Protective Clothing or Equipment: as required to avoid contact.

Work/Hygienic Practices: Wash after use. Follow good industrial hygienic practices.

Section IX: Additional Information

DOT Classification: Hazardous? Yes Name: Corrosive Mtl., Sodium Hydroxide, Flake, Compounded, UN1823, RQ1000/454

NFPA Classification (NFPA 325M, 8^{th} edition)(Health, Flammability, Reactivity): 2-0-1

* * *

The information and recommendations contained within this publication have been compiled from sources believed to be reliable and to represent the best information available to JOHNSON MANUFACTURING at the time of issue. No warranty, guarantee, or representation is made by JOHNSON MANUFACTURING nor does JOHNSON MANUFACTURING assume any responsibility in connection therewithin; nor can it be assumed that all acceptable safety measures or other safety measures may not be required under particular or exceptional conditions or circumstances.

* * *

NE = not established

918334 ***MATERIAL SAFETY DATA SHEET*** Page 1 of 2

MEDICAL EMERGENCY ONLY, 24 HOUR SERVICE: 1-800-328-0026

Ecolab Inc.
St. Paul MN 55102

Product Information: 1-612-293-2233
Date of Issue: March 3, 1987

1.0 IDENTIFICATION /

USED TO MAKE MART TORNADO PARTS WASHER ALKALINE CLEANING SOLU

1.1 Product Name: GUARDIAN
1.2 Product Type: High Alkaline Chlorinated Powdered Automatic Dishmachine Detergent

2.0 HAZARDOUS COMPONENTS /

	%	TWA (mg/m3) PEL	Other
2.1 Sodium hydroxide (caustic soda) 1310-73-2	30	2	2 C
2.2 Sodium dichloroisocyanurate 2893-78-9	3	None	UNK

This product contains no other component considered hazardous according to the criteria of 29 CFR 1910.1200.

3.0 PHYSICAL DATA /

3.1 Appearance and Odor: Blue speckled granular powder - slight chlorine odor.
3.2 Solubility in Water: Complete
3.3 pH: (0.2%) 12.0-13.0

4.0 FIRE AND EXPLOSION DATA /

4.1 Special Fire Hazards: None
4.2 Fire Fighting Methods: Product does not support combustion. Use CO2 or dry chemicals for fires near this product. Wetting containers can cause exothermic reaction releasing chlorine gas.

5.0 REACTIVITY DATA /

5.1 Stability: Stable under normal conditions of handling.
5.2 Conditions to Avoid: Reacts violently with acids. Reacts with soft metals such as aluminum and zinc.

6.0 SPILL OR LEAK PROCEDURES / USE PROPER PROTECTIVE EQUIPMENT

6.1 Cleanup: Pick up without raising dust. Flush area with water.
6.2 Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical waste.

UNK = Unknown at this time
PEL = Permissible Exposure Limit
TWA = Time Weighted Average
STEL = Short Term Exposure Level
C = Ceiling Limit, Not To Be Exceeded

7.0 HEALTH HAZARD DATA / DANGER

7.1 Effects of Overexposure:
Skin and Eyes: CAUSES SEVERE CHEMICAL BURNS. Eye contact may cause blindness. Harmful contact may not cause immediate pain.
** Immediate water flushing is vital in case of eye contact. **
If Swallowed: HARMFUL OR FATAL. Causes chemical burns of mouth, throat and stomach.
If Inhaled: Damages airways and lungs, depending upon amount and duration of exposure. Effects can vary from slight irritation to bronchitis or pneumonia. People with asthma or other lung problems may be more susceptible.

8.0 FIRST AID /

8.1 Eyes: Immediately flush with plenty of cool running water. Remove contact lenses. Continue flushing for at least 15 minutes, holding eyelids apart to ensure rinsing of the entire eye. CALL A PHYSICIAN IMMEDIATELY.
8.2 Skin: Immediately flush skin with plenty of cool running water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.
8.3 If Swallowed: Rinse mouth at once; then drink 1 or two large glasses of water or milk. DO NOT induce vomiting. NEVER give anything by mouth to an unconscious person.
8.4 If Inhaled: Immediately move to fresh air.

CALL A POISON CONTROL CENTER OR PHYSICIAN IMMEDIATELY

9.0 SPECIAL PROTECTION INFORMATION /

9.1 Respiratory: Avoid misting conditions or dusts.
9.2 Skin: Rubber gloves - protective cuff or gauntlet type preferred.
9.3 Eyes: Splashproof glasses, goggles or face shield.
9.4 Other: Avoid contact with use solutions of this product, as these may also be hazardous.

10.0 ADDITIONAL INFORMATION/PRECAUTIONS /

10.1 DOT Class: Corrosive Material UN 1759
10.2 Keep product dry; do not store in wet, moist areas.
10.3 To insure maximum shelf-life, store below 100 deg F.

KEEP OUT OF REACH OF CHILDREN

The above information is believed to be correct with respect to the formula used to manufacture the product. As data, standards and regulations change, and conditions of use and handling are beyond our control, NO WARRANTY, EXPRESS OR IMPLIED, IS MADE AS TO THE COMPLETENESS OR CONTINUING ACCURACY OF THIS INFORMATION.

O-S-801C
AMENDMENT 2
September 21, 1987
SUPERSEDING
AMENDMENT 1
April 30, 1984

FEDERAL SPECIFICATION

SULFURIC ACID, ELECTROLYTE; FOR STORAGE BATTERIES

This amendment, which forms a part of Federal Specification O-S-801C, dated October 20, 1978, is approved by the Assistant Administrator, Office of Federal Supply and Services, General Services Administration, for the use of all Federal agencies.

PAGE 3

Delete MIL-STD-1188 from the list of military standards and add the following:

"MIL-STD-1190 - Minimum Guidelines For Level C Preservation, Packing and Marking"

Add the following to the list of ASTM Standards: "ASTM D 3951 - Commercial Packaging."

Add the following publication:

"United Nations

Recommendations on the Transport of Dangerous Goods

(Application for copies should be addressed to United Nations, Sales Section, New York, NY or Geneva, Switzerland.)"

PAGE 9

4.2.4.7, line 7: Delete the equation for percent fixed residue and substitute the following:

$$\text{"Percent fixed residue} = \frac{100A\text{"}}{BC}$$

FSC 6810

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

PAGE 11

4.2.4.12, line 13: Delete the equation for percent zinc and substitute the following:

$$\text{"Percent zinc} = \frac{100A\text{"}}{BC}$$

4.2.5, line 1: Delete "Tests shall be conducted as follows:" and substitute "Containers shall be tested in accordance with chapter 9.7 of UN Recommendations and as follows:"

PAGE 16

5.1.1.2(b), line 4: Delete "conforming to DOT specification 2U."

5.1.1.2(b), lines 5 and 6: Delete in their entirey and substitute "to type I, class B, of PPP-C-569. Each bottle shall be furnished with a".

PAGE 17

5.1.3.2, line 2: Delete "MIL-STD-1188" and substitute "ASTM D 3951 and DOT regulations."

PAGE 20

5.2.3.2, line 2: Delete "MIL-STD-1188" and substitute "MIL-STD-1190 and DOT regulations."

5.3, line 1: Delete "Marking." and substitute "Marking. Inner, outer, and single packaging containers shall be marked in accordance with chapter 9.5 of UN Recommendations."

5.3.2, line 3: Delete "MIL-STD-1188" and substitute "MIL-STD-1190 and DOT regulations."

PAGE 21

5.3.3, line 6: Add the word "then" between "for eyes," and "get medical attention."

5.4: Delete paragraph in its entirety and substitute the following:

"5.4 Palletization. Like packs of sulfuric acid shall be palletized upright together.

5.4.1 Levels A and B. Level A and B packs shall be palletized in accordance with the applicable requirements of MIL-STD-147 as follows: specified containers shall be palletized using the wood cap and inverted wood cap (storage aid 5), side framing (storage aid 10) with a minimum of three vertical struts per side and end framing (storage aid 12) of MIL-STD-147. The pallet shall conform to new, unused, seasoned hardwood, type IV of NN-P-71. The caps and frames shall be fastened together in such a manner that there is a half-inch space between the top of the load and the nearest member of the top cap. Pallet loads shall not exceed four tiers in height. Pallet loads shall be secured using metal strapping in accordance with metallic strapping requirements of MIL-STD-147 as bonding means L (tie-down, straps, secondary) and M (tie-down straps, auxiliary).

5.4.2 Level C. Level C packs for military activities shall be palletized in accordance with the policies established in MIL-STD-1190. Level C packs for civil agencies shall be palletized to assure safe delivery to the first destination. Excess shipping containers which do not constitute a full pallet course and have a combined gross weight of 200 pounds or more shall be prepared for shipment in a manner which will assure transport of the containers in a unitized state from the initial source to the ultimate destination. The containers shall be consolidated in such a manner that will enable the load to be moved by forklift or other mechanical means. Excess shipping containers which do not constitute a full pallet course and have a combined gross weight of 199 pounds or less may be shipped as individual containers."

MILITARY INTERESTS:

Custodians:

Army - EA
Navy - SH
Air Force - 68

Review activities:

Army - MD, MI
Navy - YD
DLA - GS

User activities:

Navy - MC, SA

CIVIL AGENCY COORDINATING ACTIVITIES:

EPA
GSA-FSS (10FTE)

Preparing activity:

Army -

Project No. 6810-1020

G-96-05

O-S-801C
October 20, 1978
SUPERSEDING
Fed. Spec. O-S-801B
April 14, 1965 and
MIL-S-207B
November 3, 1965

FEDERAL SPECIFICATION

SULFURIC ACID, ELECTROLYTE; FOR STORAGE BATTERIES

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers four classes of sulfuric acid for use in storage batteries.

1.2 Classification. Sulfuric acid, electrolyte shall be of the following classes as specified (see 6.2):

Class 1 - Concentrated sulfuric acid; minimum specific gravity 1.8354 at 60°/60° F.
Class 2 - Dilute sulfuric acid; specific gravity 1.3945 to 1.4042 at 60°/60° F.
Class 3 - Dilute sulfuric acid; specific gravity 1.2767 to 1.2853 at 60°/60° F.
Class 4 - Dilute sulfuric acid; specific gravity 1.2085 to 1.2185 at 60°/60° F.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Federal Specifications:

L-P-390 - Plastic, Molding and Extrusion Material, Polyethylene and Copolymers (Low, Medium, and High Density).
HH-I-585 - Insulation, Thermal.
NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).

FSC 6810

THIS DOCUMENT CONTAINS 22 PAGES.

QQ-S-781 - Strapping, Steel, and Seals.
PPP-B-585 - Boxes, Wood, Wirebound.
PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636 - Boxes, Shipping, Fiberboard.
PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall.
PPP-B-1163 - Box, Corrugated Fiberboard, High Compression Strength, Weather-Resistant, Wax-Resin Impregnated.
PPP-C-186 - Containers, Packaging and Packing for Drugs, Chemicals and Pharmaceuticals.
PPP-C-569 - Containers, Plastic, Molded (For Liquids, Pastes, and Powders): Overpacked.
PPP-C-1337 - Containers, Composite; (Steel Drum With Polyethylene Insert).
PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.
PPP-T-66 - Tape: Pressure-Sensitive Adhesive, Vinyl Plastic Film
PPP-T-97 - Tape, Pressure-Sensitive Adhesive, Filament Reinforced

Federal Standards:

Fed. Test Method Std. No. 101 - Preservation, Packaging, and Packin Materials: Test Procedures.
Fed. Std. No. 123 - Marking for Shipment (Civil Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Philadelphia, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Houston, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specifications:

MIL-C-5501/7 - Caps and Plugs, Protective, Dust and Moisture Seal (Cap-Plug, General Purpose).
MIL-D-43703 - Drums, Shipping and Storage, Molded Polyethylene.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-147 - Palletized Unit Loads for 40" by 48" Pallets.
MIL-STD-1188 - Commercial Packaging of Supplies and Equipment.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Laws and Regulations:

49 CFR 171 to 179 - Department of Transportation Rules and Regulations for the Transportation of Explosives and Other Dangerous Articles.

(The Department of Transportation regulations are a part of the Code of Federal Regulations available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402. Orders for the above publications should cite "49 CFR 171 to 179.")

American Society for Testing and Materials (ASTM) Standard:

D1193 - Reagent Water.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

Society of Plastics Industry, Inc.:

SP-400 Finish For Plastic Bottles

(Application for copies should be addressed to Seajay, Inc., Apple Street, New Shrewsbury, NJ 07724.)

3. REQUIREMENTS

3.1 Material. Sulfuric acid shall be nonfuming and free from sediment when tested as specified in 4.2.4.1.

3.2 Color. Sulfuric acid shall have a color no darker than that of a standard color solution when tested as specified in 4.2.4.2.

3.3 Acid content and specific gravity. Sulfuric acid shall conform to the applicable characteristics of table I when tested for acid content as specified in 4.2.4.3 and specific gravity at 60°/60° F as specified in 4.2.4.4.

TABLE I. Acid content and specific gravity

Class	Acid content, percent by weight		Specific gravity at 60°/60° F	
	Minimum	Maximum	Minimum	Maximum
Class 1	93.2	—	1.8354	—
Class 2	49.5	50.5	1.3945	1.4042
Class 3	36.5	37.5	1.2767	1.2853
Class 4	28.3	29.5	1.2085	1.2185

3.4 Impurities. Sulfuric acid shall conform to the maximum impurities characteristics of table II when tested as specified therein.

TABLE II. Maximum impurities

Impurity	Maximum percent by weight				Test paragraph
	Class 1	Class 2	Class 3	Class 4	
Organic matter	*	*	*	*	4.2.4.5
Platinum	*	*	*	*	4.2.4.6
Fixed residue	0.03	0.016	0.012	0.009	4.2.4.7
Sulfurous acid	0.004	0.0022	0.0016	0.0013	4.2.4.8
Iron	0.005	0.0027	0.0020	0.0016	4.2.4.10
Copper	0.005	0.0027	0.0020	0.0016	4.2.4.11**
Zinc	0.004	0.0022	0.0016	0.0013	4.2.4.12
Arsenic	0.0001	0.00005	0.00004	0.00003	4.2.4.13
Antimony	0.0001	0.00005	0.00004	0.00003	4.2.4.14**
Selenium	0.002	0.0011	0.0008	0.0006	4.2.4.15**
Nickel	0.0001	0.00005	0.00004	0.00003	4.2.4.16
Manganese	0.00002	0.000011	0.000008	0.000006	4.2.4.17
Nitrate	0.0005	0.00027	0.00020	0.00016	4.2.4.18
Ammonium	0.001	0.0005	0.0004	0.0003	4.2.4.19
Chloride	0.001	0.0005	0.0004	0.0003	4.2.4.20

*To pass test.
**See 4.2.4.9 for preliminary test.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or ~~any~~ other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to the specified requirements.

4.2 Quality conformance inspection.

4.2.1 Lotting. A lot shall consist of the sulfuric acid, electrolyte offered for acceptance at one time which has been produced by one manufacturer, at one plant, during one shift, from the same materials, and under essentially the same manufacturing conditions provided the operation is continuous. In the event the process is a batch operation, each batch shall constitute a lot (see 6.3).

4.2.2 Sampling.

4.2.2.1 For sulfuric acid tests. Sampling shall be conducted in accordance with table III. A representative specimen of approximately 1 liter shall be removed from each sample container and placed in a suitable clean, dry container labeled to identify the lot and container from which it was taken.

TABLE III. Sampling for sulfuric acid tests

Number of containers in batch or lot	Number of sample containers
2 to 50	2
51 to 500	3
501 to 35,000	5
Over 35,000	8

4.2.2.2 For examination of preparation for delivery and container tests. Sampling shall be conducted in accordance with table IV.

TABLE IV. Sampling for examination of preparation for delivery and container tests

Examination or test	MIL-STD-105, inspection level	AQL, percent defective
Examination of preparation for delivery	S-3	2.5
Container leakage test	S-4	1.5
Container contamination test	S-3	1.5
Container shock resistance test	S-1	4.0

4.2.3 Inspection procedure.

4.2.3.1 For sulfuric acid tests. Each specimen taken in 4.2.2.1 shall be tested as specified in 4.2.4. Failure of any test by any specimen shall be cause for rejection of the lot represented.

4.2.3.2 For examination of preparation for delivery. The sample unit shall be one filled unit, intermediate, or shipping container, as applicable, ready for shipment. Sample unit, intermediate, and shipping containers shall be examined for the following defects using inspection level S-3 and an AQL of 2.5 percent defective:

(a) Contents per container not as specified
(b) Container not as specified
(c) Container closure not as specified or not tight
(d) Container damaged or leaking
(e) Plug missing, not as specified, or improperly seated in DOT 2U container closure neck
(f) Spout not extendable from DOT 2U container
(g) Spout of DOT 2U container not easily accessible
(h) Reinforcing straps or tape missing, loose, not as specified, or causing damage to the container (where required)
(i) Cushioning material not as specified or missing (where required)
(j) Fiberboard packing aids missing, not as specified, or improperly placed (where required)
(k) Marking incorrect, missing, illegible, or not durable
(l) Palletization not as specified

4.2.3.3 For container tests.

(a) Leakage. The sample unit shall be one filled and closed unit container. Sample unit containers shall be selected in accordance with table IV and tested for leakage as specified in 4.2.5.1.

(b) Contamination. The sample unit shall be one filled and closed 1-gallon polyethylene bottle in its fiberboard box. Sample containers shall be selected in accordance with table IV and tested for contamination as specified in 4.2.5.2.

(c) Shock resistance. The sample unit shall be one filled and closed intermediate fiberboard box containing a filled and closed 1-gallon polyethylene bottle. Sample containers shall be selected in accordance with table IV and tested for shock resistance as specified in 4.2.5.3.

4.2.4 Sulfuric acid tests. Water in accordance with ASTM D1193 and reagent grade chemicals shall be used throughout the tests. Where applicable, blank determinations shall be run and corrections applied where significant. Unless otherwise specified, acid and base reagents shall be concentrated acids and bases. Tests shall be conducted as follows:

4.2.4.1 Material. Visually examine the specimen for evidence of fuming and for the presence of sediment.

4.2.4.2 Color. Compare the color of 50 milliliters (ml) of the specimen in a Nessler tube with that of 50 ml of a standard contained in a second, matching Nessler tube. Prepare the standard using 0.12 milligrams (mg) of copper, 1 ml of 0.1N hydrochloric acid, and 5 ml of freshly prepared hydrogen sulfide water. Dilute to 50 ml for class 1 comparison, 120 ml for class 2 comparison, 180 ml for class 3 comparison, or 260 ml for class 4 comparison. Make the comparison vertically through the solution immediately after the preparation of the standard. The matching Nessler tubes should have a capacity of 50 ml and approximate dimensions of 30 centimeters (cm) in length by 2 cm in diameter.

4.2.4.3 Acid content. By means of a weighing buret, weighing bottle, or Dely tube, transfer an accurately weighed amount of the specimen, equivalent to 0.8 to 1.1 grams (g) of 100-percent sulfuric acid, into a porcelain casserole dish containing 100 to 150 ml of carbon dioxide-free water. Add 1 ml of phenolphthalein indicator (1 g in 50 ml ethyl alcohol and 50 ml water) and titrate to a faint permanent pink color with standard 0.5N sodium hydroxide solution. Record the volume and temperature of 0.5N sodium hydroxide solution (titer) used. Correct the volume of the titer by adding 0.00035 ml per milliliter of titer for each degree C that the sodium hydroxide solution is below the temperature of standardization or by subtracting 0.00035 ml per milliliter of titer for each degree C that the sodium hydroxide solution is above the temperature of standardization. Calculate the percent by weight sulfuric acid as follows:

$$\text{Percent sulfuric acid} = \frac{4.904AB}{W}$$

where: A = Corrected milliliters of sodium hydroxide solution used in the titration,
B = Normality of the sodium hydroxide solution, and
W = Weight of specimen in grams.

4.2.4.4 Specific gravity. Determine the specific gravity of the specimen using a suitable precision hydrometer standardized at 60° F, referred to water at 60° F. Make temperature corrections, when necessary, for deviations from the standard temperature as shown in table V. When the temperature of the acid is above the standard temperature, add the correction to the observed specific gravity value; when the temperature of the acid is below the standard temperature, subtract the correction from the observed specific gravity value.

TABLE V. Correction for temperature deviation

Class of sulfuric acid	Correction per degree F of temperature deviation
Class 1	0.00054
Class 2	0.00041
Class 3	0.00039
Class 4	0.00036

4.2.4.5 Organic matter. Heat 50 ml of the specimen in a clean beaker until the sulfuric acid begins to fume strongly. To pass test, there shall be no perceptible charring; a slight-yellow color that appears when a specimen is hot but disappears on cooling should be disregarded.

4.2.4.6 Platinum. As applicable, evaporate 10 ml of class 1, 24 ml of class 2, 36 ml of class 3, or 52 ml of class 4 specimen to dryness in a small porcelain evaporation dish set on a sand bath, but do not heat the residue unnecessarily. Cool and add 2 ml of aqua regia (4 volumes of hydrochloric acid and 1 volume of nitric acid). Cover the dish with a watchglass and digest on a steam bath for 10 minutes. Remove the watchglass and evaporate the solution to five or six drops. (If the solution accidentally evaporates completely, repeat the digestion with aqua regia and reevaporate to five or six drops.) Absorb the solution (five or six drops) in a piece of thin asbestos paper preferably not over 0.75 millimeter (mm) thick and about 0.5 cm wide and 3 cm long. (Hold the paper in a pair of crucible tongs and dip half of the paper into the solution. Dry gently over a flame. Repeat the dipping and drying operation until all of the solution has been absorbed into the asbestos paper.) Dry the paper and ignite to redness in a moderate Bunsen flame (3 to 4 inches high with good air mixture). With the asbestos paper held vertically in the Bunsen flame, momentarily shut off the flow of gas and then turn it on again so that the stream of unignited gas plays on the hot asbestos paper. Glowing of the paper indicates the presence of platinum or one of the platinum metals other than osmium or ruthenium. (Note: The glow should persist; however, if it dies out, it may be brought back by reigniting the paper although this cannot be repeated indefinitely.) The presence of platinum shall not be indicated.

4.2.4.7 Fixed residue. As applicable, measure 10 ml of class 1, 24 ml of class 2, 36 ml of class 3, or 52 ml of class 4 specimen into a platinum dish, evaporate to dryness, and ignite at a dull red heat for 5 minutes. Cool in a desiccator and weigh the residue (save the residue for iron and copper determinations). Calculate the percent by weight fixed residue as follows:

$$\text{Percent fixed residue} = \frac{A}{BC}$$

where: A = Weight of residue in grams,
B = Milliliters of specimen, and
C = Specific gravity of the specimen determined in 4.2.4.4.

4.2.4.8 Sulfurous acid. As applicable, dilute 20 ml of class 1, 49 ml of class 2, or 72 ml of class 3 specimen to 80 ml with water; in the case of the class 4 specimen, evaporate 104 ml to approximately 75 ml and dilute to 80 ml with water. Cool the 80 ml of solution to 25° C and titrate with 0.1N potassium permanganate solution to a faint but permanent pink color. No more than 0.46 ml of 0.1N potassium permanganate solution shall be required. Save the titrated solution for use in 4.2.4.9.

4.2.4.9 Preliminary test for antimony, copper, and selenium. Dilute the titrated solution from 4.2.4.8 with water to 150 ml and, if necessary, filter off any precipitate. Pass hydrogen sulfide through the solution for 5 minutes, let stand for 10 minutes, and filter without washing through a 9-cm quantitative filter paper of close texture (save the filtrate for 4.2.4.16). Unfold the paper and examine it closely, especially near the center, in daylight or equivalent artificial light. Absence of a black or brown color indicates that less than the permitted amount of copper is present and the determination of copper is to be omitted. If the paper, in the absence of a black or brown color, shows neither a light yellow nor an orange color, antimony and selenium are less than the permitted amounts and the determination of these impurities is to be omitted. (Note: If sulfur precipitates during hydrogen sulfide treatment, the preliminary test for antimony may be meaningless. The precipitation of sulfur will not obscure copper or selenium, if present.)

4.2.4.10 Iron. (If the percent fixed residue determined in 4.2.4.7 does not exceed 0.0070 for class 1, 0.0038 for class 2, 0.0028 for class 3, or 0.0022 for class 4, the determination of iron is to be omitted). Add 1 ml of hydrochloric acid to the residue retained from 4.2.4.7, warm on a steam bath to dissolve the residue, and dilute to 10 ml in a volumetric flask (solution A). Dilute a 1-ml aliquot of solution A to 100 ml in a volumetric flask (solution B). (Save the remaining 9 ml of solution A for the copper determination). To a 20-ml aliquot of solution B, add 1 ml of hydrochloric acid, 30 to 50 mg of ammonium persulfate, and 3 ml of 30 percent ammonium thiocyanate solution. The color developed shall not exceed that developed in a standard containing 0.018 mg of iron and the same quantities of reagents made up to an equal volume.

4.2.4.11 Copper. (If the percent fixed residue determined in 4.2.4.7 does not exceed 0.0060 for class 1, 0.0032 for class 2, 0.0024 for class 3, or 0.0019 for class 4, or if the preliminary test for copper in 4.2.4.9 does not indicate the presence of copper; the determination of copper is to be omitted). Neutralize the remaining 9 ml of solution A from 4.2.4.10 with ammonium hydroxide and add 4 ml in excess. Heat sufficiently to coagulate any precipitate, filter into a Nessler tube, and dilute to about 20 ml. The blue color shall not be deeper than that produced by 0.83 mg of copper in an equal volume of solution containing 4 ml of ammonium hydroxide.

4.2.4.12 Zinc. (If the percent fixed residue determined in 4.2.4.7 does not exceed 0.0060 for class 1, 0.0032 for class 2, 0.0024 for class 3, or 0.0019 for class 4; the determination of zinc is to be omitted). As applicable, dilute 20 ml of class 1, 49 ml of class 2, 72 ml of class 3, or 104 ml of class 4 specimen to approximately 110 ml and neutralize with ammonium hydroxide. Dilute the solution to 200 ml, add 10 ml of 6N sulfuric acid, and saturate with hydrogen sulfide gas. Filter the solution and boil the filtrate to remove the hydrogen sulfide. Cool the solution and neutralize with ammonium hydroxide using methyl red as the indicator. Pipet 1 ml of 1N sulfuric acid for each 100 ml of solution into the solution and pass a rapid stream of hydrogen sulfide through the solution for 20 minutes. Collect any precipitate formed on ashless filter paper, wash with water, ignite in a tared crucible, cool to room temperature in a desiccator, and weigh the collected precipitate. Calculate the percent by weight zinc as follows:

$$\text{Percent zinc} = \frac{A}{BC}$$

where: A = Weight of collected precipitate in grams,
B = Milliliters of specimen, and
C = Specific gravity of specimen determined in 4.2.4.4.

4.2.4.13 Arsenic. As applicable, dilute 20 ml of class 1, 49 ml of class 2, 58 ml of class 3, or 78 ml of class 4 specimen to 100 ml in a volumetric flask. As applicable, dilute a 20-ml aliquot of the class 1 or class 2 specimen dilution or a 25-ml aliquot of the class 3 or class 4 specimen dilution to 50 ml and determine arsenic by the modified Gutzeit procedure. The stain produced shall not exceed that produced by 0.0075 mg of arsenic. (Note: Also compare the stain with that produced by 0.00075 mg of arsenic in reference to 4.2.4.14.)

4.2.4.14 Antimony. If the arsenic content has been found to be not greater than one-tenth of the permitted limit (see note of 4.2.4.13), antimony is determined without first removing arsenic; proceed as specified in (a) below. If the arsenic content has been found greater than one-tenth the permitted limit, proceed as specified in (b) below.

(a) Procedure when arsenic content is 0.00001 percent or less. As applicable, evaporate 11 ml of class 1, 27 ml of class 2, 40 ml of class 3, or 57 ml of class 4 specimen to 4 or 5 ml. Transfer to a Gutzeit apparatus, make up to 50 ml with water, and proceed as in the determination of arsenic except that the solution is finally warmed to 60° C and kept at 60° ± 3° C for 1 hour. Develop the stain by immersing the paper strip (mercuric bromide paper) in 20 percent by volume ammonium hydroxide solution. The stain developed shall not exceed that produced by 0.02 mg of antimony following the same procedure.

(b) **Procedure when arsenic content is greater than 0.00001 percent.** As applicable, evaporate 55 ml of class 1, 110 ml of class 2, 162 ml of class 3, or 225 ml of class 4 specimen to 4 or 5 ml in a 250-ml beaker. Cool to room temperature and cautiously add 10 ml of water containing 0.25 g of sodium sulfite. Mix and evaporate until the solution begins to fume. Cool and add 100 ml of hydrochloric acid. Boil slowly (in the open beaker) until the volume is reduced to 40 to 45 ml keeping the temperature of the liquid below 110° C. (Use boiling tubes or chips to minimize bumping and take care not to let the volume get too small or the temperature get too high; otherwise some antimony may be lost.) Transfer the reduced volume quantitatively, with a minimum amount of water, to a 50-ml volumetric flask and make up to volume with water. To a 10-ml aliquot, add 10 ml of water and 3 ml of reagent sulfuric acid. Mix, transfer to a Gutzeit apparatus, dilute to 50 ml and proceed as specified in (a). The stain developed shall not exceed that produced by a solution containing 0.02 mg antimony, 3 ml of reagent sulfuric acid, and 4 ml of hydrochloric acid.

4.2.4.15 **Selenium.** (If the preliminary test for selenium in 4.2.4.9 was negative, the determination of selenium is to be omitted.) Classes 2, 3, and 4 specimens require concentrating prior to determining selenium; concentrate by evaporating 20 to 30 ml until the heavy fumes of sulfuric acid appear. As applicable, place 3 ml of class 1 or concentrated class 2, 3, or 4 specimen in a test tube. Cool the test tube and contents in an ice bath. Overlay the test tube contents with 10 ml of hydrochloric acid containing approximately 10 mg of sodium sulfite. (Note: Initially, with care, add just enough of the hydrochloric acid to cover the surface of the contents in the test tube, wait until any effervescence ceases, then continue to overlay with the remaining portion of the 10 ml of hydrochloric acid.) Observe the zone of contact between the two liquids for 3 minutes from the time the specimen is completely covered by the first addition of hydrochloric acid. The formation of a red to reddish-brown ring denotes the presence of a selenium content exceeding the permitted limit. (Note: In the presence of iron or copper, a yellow ring will form in the zone of contact. The red to reddish-brown ring of selenium, if present, will form slightly above and separate from the yellow ring of iron or copper. The red to reddish-brown ring should be viewed transversely against a white background and not be confused with the yellow ring.)

4.2.4.16 **Nickel.** Gently boil 50 ml of the filtrate retained from 4.2.4.9 to remove the excess hydrogen sulfide. Cool to room temperature, add 2 ml of 20 percent tartaric acid solution and 2 ml of water saturated with bromine. Slowly add ammonium hydroxide solution until the bromine color is discharged. Cool the solution to room temperature. Add 2 ml of ammonium hydroxide solution, 2 ml of a 1-percent solution of dimethylglyoxime in alcohol, and 1 ml of water saturated with bromine. Any color produced shall not exceed that produced by 0.012 mg of nickel in an equal volume of solution treated in the same manner as the specimen solution filtrate after boiling.

4.2.4.17 Manganese. As applicable, dilute 20 ml of class 1, 49 ml of class 2, or 72 ml of class 3 specimen to 95 ml with water and add 5 ml of nitric acid; in the case of class 4 specimen, evaporate 104 ml to approximately 90 ml, dilute to 95 ml with water, and add 5 ml of nitric acid. Add 5 ml of 85-percent phosphoric acid. Add 0.5 g of potassium periodate and boil the solution vigorously in a covered beaker for 5 minutes. Cool to room temperature. The color shall be no deeper than that of a standard containing 0.7 ml of 0.001N potassium permanganate solution diluted to 95 ml with water and treated in the same manner.

4.2.4.18 Nitrate.

(a) Standard nitrate solution. Prepare a stock nitrate solution by dissolving 0.625 g of potassium nitrate in water in a 1-liter volumetric flask and make up to volume. Prepare a standard nitrate solution by pipeting 20 ml of the stock solution into a 1-liter volumetric flask and make up to volume. (The standard solution contains 0.00766 mg of nitrate per milliliter.)

(b) Class 1. Pipet 10 ml of water into one of a matched pair of Nessler tubes and add, by pipet, 5 ml of class 1 specimen and 15 ml of nitrate-free reagent sulfuric acid. Into the second Nessler tube, pipet 4 ml of water and 6 ml of the standard nitrate solution prepared in (a). Add, by pipet, 20 ml of nitrate-free reagent sulfuric acid. To each Nessler tube, add 0.5 ml of a saturated solution of ferrous sulfate and mix. Immediately after mixing, the color or darkening of the solution in the Nessler tube containing the class 1 specimen shall not exceed that of the solution in the Nessler tube containing the standard nitrate solution. (Note: Only the difference in color is to be considered, not the turbidity which may be present due to the precipitation of lead sulfate when the specimen is diluted.)

(c) Class 2. Pipet 10 ml of class 2 specimen into one of a matched pair of Nessler tubes and add, by pipet, 10 ml of nitrate-free sulfuric acid. Into the second Nessler tube, pipet 5 ml of the standard nitrate solution prepared in (a) and add, by pipet, 15 ml of nitrate-free reagent sulfuric acid. To each Nessler tube, add 0.5 ml of a saturated solution of ferrous sulfate and mix. Immediately after mixing, the color or darkening of the solution in the Nessler tube containing the class 2 specimen shall not exceed that of the solution in the Nessler tube containing the standard nitrate solution. See note in (b).

(d) Class 3. Pipet 15 ml of class 3 specimen into one of a matched pair of Nessler tubes and add, by pipet, 5 ml of nitrate-free sulfuric acid. Into the second Nessler tube, pipet 5 ml of the standard nitrate solution prepared in (a) and add, by pipet, 15 ml of nitrate-free reagent sulfuric acid. To each Nessler tube, add 0.5 ml of a saturated solution of ferrous sulfate and mix. Immediately after mixing, the color or darkening of the solution in the Nessler tube containing the class 3 specimen shall not exceed that of the solution in the Nessler tube containing the standard nitrate solution. See note in (b).

(e) Class 4. Pipet 20 ml of class 4 specimen into one of a matched pair of Nessler tubes. Into the second Nessler tube, pipet 5 ml of water and 5 ml of the standard nitrate solution prepared in (a) and add, by pipet, 10 ml of nitrate-free reagent sulfuric acid. To each Nessler tube, add 0.5 ml of a saturated solution of ferrous sulfate and mix. Immediately after mixing, the color or darkening of the solution in the Nessler tube containing the class 4 specimen shall not exceed that of the solution in the Nessler tube containing the standard nitrate solution. See note in (b).

4.2.4.19 Ammonium. As applicable, dilute 20 ml of class 1, 49 ml of class 2, 58 ml of class 3, or 76 ml of class 4 specimen to 100 ml in a volumetric flask. As applicable, in a Nessler tube, dilute 20 ml of the class 1 or class 2 specimen dilution or dilute 25 ml of the class 3 or class 4 specimen dilution to 90 ml with water, make alkaline with sodium hydroxide solution, and add 1 ml of Nessler's reagent. The color produced shall not exceed that produced by 0.072 mg of ammonium ion (1 ml of a 1-liter solution of 0.22 g of ammonium chloride in water) treated in the same manner.

4.2.4.20 Chloride. As applicable, dilute 20 ml of class 1, 49 ml of class 2, 36 ml of class 3, or 49 ml of class 4 specimen to 100 ml in a volumetric flask. As applicable, in a Nessler tube, dilute 5 ml of the class 1 or class 2 specimen dilution or dilute 10 ml of the class 3 or class 4 specimen dilution to 50 ml with water. Add 1 ml of 1 to 10 nitric acid and 1 ml of 2-percent silver nitrate solution. The turbidity produced shall not exceed that produced by 0.018 mg of chloride ion (1 ml of a 1-liter solution of 0.030 g of sodium chloride in water) treated in the same manner.

4.2.5 Container tests. Tests shall be conducted as follows:

4.2.5.1 Leakage. Place the container in an inverted position at a temperature of 75° ± 5° F for 4 hours. Observe the container for evidence of leakage during and at the end of this test.

4.2.5.2 Contamination. Use clean, contamination-free gloves during the testing. Wipe the entire exterior surface of the polyethylene container and the exposed surfaces of the box flaps with neutral or blue litmus indicator paper. Special attention should be paid to the area around the seams and the plug closure in the spout. Red coloration of the litmus paper shall be considered evidence of sulfuric acid contamination.

4.2.5.3 Shock resistance. Condition the container for 72 hours at -40° ± 2° F prior to testing. Subject the container to a free fall drop test in accordance with procedures B and E, method 5007 of Fed. Test Method Std. No. 101 until the drop cycle is completed or failure occurs. After the test has been completed, invert the container and allow it to remain in this position for 24 hours before opening to inspect for leakage.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Sulfuric acid shall be packaged level A, B, or C as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Five-pint quantity, class 1 sulfuric acid. A quantity of 5 pints [+1 or -0 fluid ounces (oz)] of class 1 sulfuric acid shall be packaged in a nominal 5-pint capacity glass bottle in accordance with Department of Transportation (DOT) regulations. The bottle shall conform to group A, class 1, type 4, grade 2, closure A, seal A of PPP-C-186. The closure A of PPP-C-186 shall be made of styrene-acrylonitrile or a material of equal or better durability in this service. The closure shall be secured to the neck of the bottle by tightening to a torque of 18 to 25 pound-inches. Seal A of PPP-C-186 shall secure the screw-cap to the neck of the bottle by the circumferential application of a minimum of 1-1/3 turns of tape conforming to type optional of PPP-T-66. The tape shall extend from the top of the cap to well down around the neck of the bottle. Alternatively, a self-shrinking outerseal meeting the minimum performance requirements of this tape shall be acceptable. The closed bottle shall not leak when tested as specified in 4.2.5.1. The closed bottle shall be placed upright in an expanded polystyrene case in accordance with DOT Specification 33A and the case shall be closed for shipment by using waterproof tape as specified therein. The polystyrene case shall then be overpacked in a close-fitting fiberboard box conforming to grade W5c of PPP-B-636.

5.1.1.2 One-gallon (gal) quantity.

(a) Class 1 sulfuric acid. A quantity of 1 US gal (+1 or -0 oz of class 1 sulfuric acid shall be unit packaged as specified in 5.1.1.1 except that the unit container shall be a nominal 1-gal capacity glass bottle or jug. The closed bottle or jug shall not leak when tested as specified i 4.2.5.1. The closed bottle or jug shall be centered upright in a fiberboar box conforming to type CF, class domestic, variety DW, grade 200 of PPP-B-636 and having minimum inside dimensions of 10 by 10 by 17 inches. Vermiculite conforming to type IV, class 1 of HH-I-585 shall be added to protect all surfaces of the bottle or jug and to completely fill the box. The box shall be closed by taping all seams as specified in PPP-B-636.

(b) Classes 2, 3, and 4 sulfuric acid. A quantity of 1 US gal (+1 or -0 oz) of class 2, 3, or 4 sulfuric acid as specified (see 6.2) shall be packaged in a nominal 1-gal capacity rectangular polyethylene bottle conforming to DOT Specification 2U in a fiberboard box conforming to type I of PPP-C-569 except that the bursting strength shall be no less than 200 pounds per square inch. Each bottle shall be furnished with a nonintegral spout which has been injection molded from virgin natural polyethylene conforming to type I, class H, grade optional or type I, class M, grade 2 of L-P-390. The spout shall be designed and sized to conform to Glass Container Manufacturer's Institute Standards as modified by the Society of the Plastics Industry, Incorporated for a nominal 38-millimeter (mm) diameter screw cap with a minimum of one and one-half turns of a buttress thread. The inner surface and top rim of the spout shall be properly sized and sufficiently smooth and concentric to form a leakproof mating surface with the plug which is inserted after filling. A snug-fitting plug conforming to MIL-C-5501/7 shall be inserted into the opening of the spout of the filled bottle until the underside of the shoulder of the plug is in full contact with the top rim of the spout. Before applying the screw-cap, the exterior of the filled bottle shall show no evidence of contamination by sulfuric acid when tested as specified in 4.2.5.2. The plug shall then be secured tightly in place in the spout by a nominal 38-mm diameter phenolic buttress screw-thread cap designed to match the spout. The fiberboard box shall be perforated to provide for easy removal of a section to permit ready access to and extension of the pouring spout. The box shall be closed as specified in the appendix to PPP-C-569. The filled and closed box shall show no evidence of leakage when tested for shock resistance as specified in 4.2.5.3.

5.1.2 Level B.

5.1.2.1 One-gal quantity, classes 2, 3, and 4 sulfuric acid. A quantity of 1 US gal (+1 or -0 oz) of class 2, 3, or 4 sulfuric acid as specified (see 6.2) shall be packaged as specified in 5.1.1.2(b) except that the fiberboard box shall conform to the DOT Specification 12B special box for DOT Specification 2U containers not over 5-gal in capacity, and the box shall be formed from board having a classified completed strength of no less than 200 pounds. The fiberboard box shall be perforated to provide for easy removal of a section to permit ready access to and extension of the pouring spout. The polyethylene container shall be tested for contamination and the fiberboard box shall be tested for shock resistance as specified in 5.1.1.2(b).

5.1.3 Level C.

5.1.3.1 Civil agencies. A quantity of sulfuric acid as specified (see 6.2) shall be packaged to assure carrier acceptance and safe delivery to the first domestic destination. Containers shall be in accordance with DOT regulations and applicable carrier regulations.

5.1.3.2 Military activities. A quantity of sulfuric acid as specified (see 6.2) shall be packaged in accordance with MIL-STD-1188.

5.2 Packing. Sulfuric acid shall be packed level A, B, or C as specified (see 6.2).

5.2.1 Level A.

5.2.1.1 Five-pint quantity, class 1 sulfuric acid. Four single bottle cases of class 1 sulfuric acid packaged as specified in 5.1.1.1 shall be packed upright in accordance with DOT regulations in a close-fitting wood box conforming to class 2, grade A, style 4 of PPP-621; type overseas, style A, B, or I, grade A of PPP-B-601; or class 3, style optional of PPP-B-585 with wood preserved as specified for grade A of PPP-B-621. The box shall be for a type 2 load. Motion of contents shall be prevented by the insertion, where needed, of fiberboard pads formed from material conforming to grade V3c of PPP-F-320. The box shall be closed and reinforced as specified in the appendix to the applicable box specification.

5.2.1.2 One-gal quantity.

(a) Class 1 sulfuric acid. Four 1-gal containers of class 1 sulfuric acid packaged as specified in 5.1.1.2(a) shall be packed upright in a wood box as specified in 5.2.1.1.

(b) Classes 2, 3, and 4 sulfuric acid. Four packages of class 2, 3, or 4 sulfuric prepared as specified in 5.1.1.2(b) shall be packed upright in a close-fitting impregnated fiberboard box conforming to style RSC, class I, type SWCFI, grade 275 of PPP-B-1163. When specified (see 6.2), the four packages of class 2, 3, or 4 sulfuric acid shall be packed upright in a close-fitting cleated fiberboard box conforming to class 2, style A of PPP-B-640. Motion of contents shall be prevented by the insertion, where needed, of the same fiberboard as that used for the box. The box shall be closed by water-resistant adhesive plus staples and the box shall be reinforced by strapping as specified in the appendix to the box specification. If staples are used, fiberboard pads shall be inserted, where needed, to prevent the staples from puncturing the inner containers. The containers shall show no evidence of leakage of contents when tested as specified in 4.2.5.1.

5.2.1.3 Five-gal quantity, class 2 sulfuric acid. A quantity of 5 US gal (+6 or -0 oz) of class 2 sulfuric acid shall be packed in accordance with DOT regulations in a nominal 5-gal capacity container conforming to type II, class 1 of PPP-C-1337 or DOT Specification 34 as specified (see 6.2). The container shall show no evidence of leakage of contents when tested as specified in 4.2.5.1.

5.2.1.4 Six and one-half-gal quantity, class 1 sulfuric acid. A quantity of 6-1/2 US gal (+8 or -0 oz) of class 1 sulfuric acid shall be packed in accordance with DOT regulations in a nominal 6-1/2-gal capacity glass carboy conforming to DOT Specification 1A, 1C, or 1K or in a glass carboy totally enclosed by an outside container formed from foamed polystyrene and permitted by DOT as an exception to existing specifications as specified (see 6.2). The outside container shall completely enclose the closure neck and body of the glass carboy. The closure of the outside container shall be reinforced by no less than two steel straps of 1/2-inch minimum width conforming to class 1, type optional of QQ-S-781 applied vertically and at right angles to each other. The outside polystyrene container closure shall be secured by tape conforming to type IV of PPP-T-97 rather than by the steel straps specified above. One continuous strip of the tape shall encircle and be vertically centered over the surface of the polystyrene container. Another continuous strip of the tape, no less than 3 inches wide, shall encircle the case and be centered over the seam between the top and bottom sections. The strips of tape shall overlap no less than 3 inches. The containers shall show no evidence of leakage of contents when tested as specified in 4.2.5.1.

5.2.1.5 Fifteen-gal quantity, class 3 sulfuric acid. A quantity of 15 US gal (+1 or -0 pint) of class 3 sulfuric acid shall be packed in a nominal 15-gal container conforming to type II, class 2A of PPP-C-1337 or size II of MIL-D-43703 as specified (see 6.2) except that aside from the requirement for rolling rings, the shape and dimensions of the drum shall not be restricted to that specified, but shall be restricted to any compact configuration meeting the specified performance requirements and DOT regulations. The container shall show no evidence of leakage of contents when tested as specified in 4.2.5.1.

5.2.2 Level B.

5.2.2.1 Five-pint quantity, class 1 sulfuric acid. Four individually cased 5-pint bottles of class 1 sulfuric acid packaged as specified in 5.1.1.1 shall be packed upright as specified in 5.2.1.1 except that the box shall conform to grade V3c of PPP-B-636.

5.2.2.2 One-gal quantity.

(a) Class 1 sulfuric acid. Four 1-gal containers of sulfuric acid packaged as specified in 5.1.1.2(a) shall be packed upright as specified for the four single bottle cases in 5.2.1.1 except that the box shall conform to type domestic, style A, B, or I, grade B of PPP-B-601 or class 1, style optional of PPP-B-585.

(b) Classes 2, 3, and 4 sulfuric acid. Four packages of class 2, 3, or 4 sulfuric acid prepared as specified in 5.1.2.1 shall be packaged upright in a snug-fitting box meeting the minimum requirements of grade V3c of PPP-B-636. Motion of contents shall be prevented by the insertion, where needed, of pads formed from fiberboard conforming to grade V3c of PPP-F-320. The box shall be closed and reinforced as specified in the appendix to PPP-B-636. The containers shall show no evidence of leakage of contents when tested as specified in 4.2.5.1.

5.2.2.3 Five-gal quantity, class 2 sulfuric acid. A quantity of 5 US gal (+6 or -0 oz) of class 2 sulfuric acid shall be packed as specified in 5.2.1.3 except that the type I, class 1 container of PPP-C-1337 or DOT Specification 34 as specified (see 6.2) shall be required.

5.2.2.4 Six and one-half-gal quantity, class 1 sulfuric acid. A quantity of 6-1/2 US gal (+8 or -0 oz) of class 1 sulfuric acid shall be packed as specified in 5.2.1.4 except that carboys conforming to DOT Specification 1D, 1X, or 34 as specified (see 6.2) shall also be permitted and reinforcement strapping shall not be required unless specified by DOT regulations.

5.2.2.5 Fifteen-gal quantity, class 3 sulfuric acid. A quantity of 15 US gal (+1 or -0 pint) of class 3 sulfuric acid shall be packed as specified in 5.2.1.5 except that the container of PPP-C-1337, if specified, shall conform to type I, class 2 of PPP-C-1337.

5.2.3 Level C.

5.2.3.1 Civil agencies. Sulfuric acid shall be packed to assure carrier acceptance and safe delivery to the first domestic destination. Containers shall be in accordance with DOT regulations and applicable carrier regulations.

5.2.3.2 Military activities. Sulfuric acid shall be packed in accordance with MIL-STD-1188.

5.3 Marking.

5.3.1 Civil agencies. Shipments shall be marked in accordance with DOT regulations, Fed. Std. No. 123, and the precautionary marking specified in 5.3.3.

5.3.2 Military activities. Levels A and B shipments shall be marked in accordance with DOT regulations and MIL-STD-129. Level C shipments shall be marked in accordance with MIL-STD-1188. All packages and packs shall be marked to show lot number, date of manufacture of contents, and the precautionary marking specified in 5.3.3.

5.3.3 Precautionary marking. Each container shall be marked to clearly show the top of the container by the use of an arrow and the word "UP." Each fiberboard box specified in 5.1.1.2(b) and 5.1.2.1 and similar commercial containers shall show the directions and precautions to be observed for opening and pouring the contents; the marking shall include the words "DO NOT REMOVE LINER FROM CARTON" and an arrow and the word "POUR" indicating that the container should be held with the pouring spout in the uppermost position while the contents are being poured into a storage battery. Each container shall also be marked to show, as a minimum, the following:

DANGER! CAUSES SEVERE BURNS
Do not get in eyes, on skin, or on clothing.
Personal protective equipment, to include eye protection, must be worn when dispensing the contents of this container.

Adequate water supply for quick drenching or flushing the eyes and body must be available within the work area for emergency use.
In case of contact, immediately flush eyes and skin with generous quantities of water for at least 20 minutes; for eyes, get medical attention.
Do not add water to contents of this container because of violent reaction.

5.4 Palletization. Like packs of sulfuric acid shall be palletized upright together. Levels A and B packs shall be palletized in accordance with the applicable requirements of MIL-STD-147. Polyethylene containers with or without a fiberboard overpack and carboys inclosed in foamed polystyrene shall be palletized using the wood cap and inverted wood cap (storage aid 5), side framing (storage aid 10), and end framing (storage aid 12) of MIL-STD-147. The pallet shall conform to new, unused, seasoned softwood or hardwood, type IV of NN-P-71. Level C packs for military activities shall be palletized in accordance with the policies established in MIL-STD-1188. Level C packs for civil agencies shall be palletized to assure safe delivery to the first destination. Excess shipping containers which do not constitute a full pallet course and have a combined gross weight of 200 pounds or more shall be prepared for shipment in a manner which will assure transport of the containers in a unitized state from the initial source to the ultimate destination. The containers shall be consolidated in such a manner that will enable the load to be moved by forklift or other mechanical means. Excess shipping containers which do not constitute a full pallet course and have a combined gross weight of 199 pounds or less may be shipped as individual containers.

6. NOTES

6.1 Intended use. Sulfuric acid, electrolyte is intended for use in lead storage batteries. Class 1 sulfuric acid must be diluted to the applicable density specified for class 2, 3, or 4 before use; class 1 sulfuric acid should never be used undiluted in lead storage batteries.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Class of sulfuric acid required (see 1.2).
(c) Level of packaging required (see 5.1).

(d) Level of packing required (see 5.2).
(e) If the four packages of class 2, 3, or 4 sulfuric acid prepared in 5.1.1.2(b) shall be packed in a box conforming to PPP-B-640 [see 5.2.1.2(b)].
(f) Level A container required for 6-1/2 gal quantity of class 1 sulfuric acid (see 5.2.1.4).
(g) Level A container required for 15-gal quantity of class 3 sulfuric acid (see 5.2.1.5).
(h) Level B container required for 5-gal quantity of class 2 sulfuric acid (see 5.2.2.3).
(i) Level B container required for 6-1/2-gal quantity of class 1 sulfuric acid (see 5.2.2.4).
(j) Quantity required for level C packaging (see 5.1.3.1 and 5.1.3.2).

6.3 Batch. A batch is defined as that quantity of material which has been manufactured by some unit chemical process or subjected to some physical mixing operation intended to make the final product substantially uniform.

6.4 Significant places. For the purpose of determining conformance with this specification, an observed or calculated value should be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of the Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant in Specified Limiting Values (ASTM E29).

MILITARY INTEREST:

Custodians:

Army - EA
Navy - SH
Air Force - 68

Review activites:

Army - MD
Navy - YD
DSA - GS

User activities:

Army - MI
Navy - MC, SA

Civil Agency Coordinating Activities:

EPA
GSA-FSS

Preparing activity:

Army - EA

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